



**RESOURCE CONSERVATION AND RECOVERY ACT
INTERIM STATUS
DRAFT CLOSURE PLAN**

OPEN BURNING/OPEN DETONATION UNITS

AT

**SIERRA ARMY DEPOT
HERLONG, CALIFORNIA**

JULY 2007

prepared by

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ACRONYMS

°F	degrees Fahrenheit
µg/kg	micrograms per kilogram
µg/g	micrograms per gram
µg/L	micrograms per liter
µg/dL	micrograms per deciliter
µm	micrometers
ADA	Active Demolition Area
AOI	Area of Interest
bgs	below ground surface
BLM	Bureau of Land Management
BLU	bomb loaded unit
BRAC	Base Realignment and Closure Process
B&R Environmental	Brown and Root Environmental
BTTN	Butanetriol trinitrate
CADs	cartridge actuated devices
Cal EPA	California Environmental Protection Agency
Cal-Wet	California Waste Extraction Test
CBU	cluster bomb unit
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CITE	Centers of Industrial and Technical Excellence
COC	chemicals of concern
COE	Corps of Engineers
COPC	chemical of potential concern
Cr III	trivalent chromium
Cr VI	hexavalent chromium
CRWQCB	California Regional Water Quality Control Board
CSM	Conceptual Site Model
CTC	Cost-to-complete
DA	Department of the Army
DATB	1,3-Diamino-2,4,6-trinitrobenzene
DBP	Dibutylphthalate
DDESB	DoD Explosive Safety Board
DDNP	Diazodinitrophenol
DEGN	Diethyleneglycol dinitrate

dEIR	draft Environmental Impact Report
DMM	discarded military munitions
-DNT	2,6-dinitrotoluene
DoD	Department of Defense
DPA	Diphenylamine
DTSC	Department of Toxic Substance Control
EOD	Explosive Ordnance Disposal
EEDN	Ethylamine dinitrate
EP	Extraction Procedure
FFSRA	Federal Facility Site Remediation Agreement
FS	Feasibility Study
FSP	field sampling plan
gpm	gallons per minute
GPS	Global Positioning System
HBX	High Blast Explosive
HC	Hazard Class
HC/D	Hazard Class/Division
HE	High Explosive
HEI	High Explosive Incendiary
HERD	Health and Ecological Risk Division
HHRA	human health risk assessment
HI	hazard index
HNAB	Hexanitroazobenzene
HNUS	Halliburton NUS
HQ	Hazard Quotient
HRA	Health Risk Assessment
IAP	Installation Action Plan
ICBM	intercontinental ballistic missiles
ICM	improved conventional munitions
ICM/CBU	improved conventional munitions/cluster bomb units
KDNBF	Potassium dinitrobenzofuroxane
km	kilometer
km ²	square kilometer
LBA	Lower Burning Area
LBG	Lower Burning Ground
LMNR	Lead mononitroresorcinate
LUC	Land Use Control

MC	Munitions Constituent
MCL	Maximum Containment Level
MEC	Munitions and Explosives of Concern
mg/L	milligrams per liter
MHE	material handling equipment
MIDAS	Munitions Items Disposition Action System
MLRS	multiple launch rocket system
MMRP	Military Munitions Response Program
mph	miles per hour
MPPEH	Material Potentially Presenting an Explosive Hazard
msl	mean sea level
NATO	North Atlantic Treaty Organization
NC	Nitrocellulose
NEW	net explosive weight
NFA	no further action
NG	nitroglycerine
NOAA	National Oceanic and Atmospheric Administration
NQ	nitroguanidine
NS	nitrostarch
OB	Open Burning
OD	Open Detonation
ODA	Open Detonation Area
PADs	propellant actuated devices
PBX	plastic bonded explosive
PETN	pentaerythritol tetranitrate
ppm	parts per million
QA	quality assurance
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethylenetrinitramine
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SI	Site Investigation
SIAD	Sierra Army Depot
SLBM	submarine launched ballistic missile
STLC	Soluble Threshold Limiting Concentration
SWMUs	solid waste management units

TATB	triamino trinitrobenzene
TC	Toxicity Characteristic
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TEGDN	triethylene glycol dinitrate
TNT	trinitrotoluene
TMETN	1,1,1-trimethylamine trinitrate
TTLC	Total Threshold Limit Concentration
TtNUS	Tetra Tech NUS, Inc.
U.S.	United States
UBA	Upper Burning Area
UBG	Upper Burning Grounds
UCL	Upper Confidence Limit
UNO	United Nations Organization
USACE	United States Army Corps of Engineers
USAEHA	United States Army Environmental Health Agency
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency
USGS	United States Geological Society
UXO	unexploded ordnance
VOCs	volatile organic compounds
WET	waste extraction test

8.0 SOIL SAMPLING PLAN - 22 CCR 66265.112(B)(4)

This section provides a general summary of historical soil investigations, analytical results, and risk assessments and presents a description of the soil sampling and analysis program proposed for the Interim Status OB Unit referred to as the Lower Burning Area (LBA) and the Interim Status Open Detonation (OD) Unit known as the Active Demolition Area (ADA) during the RCRA closure investigation. The locations of the LBA and ADA are identified in Figure 1-2.

8.1 OB UNIT

OB operations consisted of the burning of solid propellants and other solid energetic materials within containment pans. The LBA at SIAD consisted of up to 40 burn pans during the operating life of the unit. Each burn pan had a capacity of up to 1,000 pounds NEW of propellant. The LBA pans were located in a pad area that comprises approximately 18 acres of the 50-acre LBA.

Section 1.6.1 contains a general description of the types of waste munitions and explosives that were treated at the SIAD OB Unit. Based on the information presented in Section 1.6.1, explosives, propellants, perchlorates, and metals are the primary COPCs for the LBA area.

8.1.1 Conceptual Site Model

Contaminants could have been released to the surrounding soil from the pans during OB operations. The OB treatment resulted in a plume that often reached several hundred feet in height. Particulate material resulting from the burning was entrained within the plumes. This particulate matter consisted of inorganic materials such as metals compounds that are contained in explosive formulations and ignition materials. In addition, untreated material could have been ejected during OB operations, and ash could have been released after burning operations were complete. Any releases would have initially been deposited onto surface soil. The particles with the greatest density and largest mass would tend to fall out in close proximity to the burn pans. As the distance from the pans increased, the expected concentrations of contaminants in surface soil would decrease. The highest concentrations of contaminants in surface soil [0 to 6 inches below ground surface (bgs)] would be expected to be found in close proximity (e.g., 0 to 50 feet) to the LBA pans. Historically, before burn pans were used, OB took place directly on the ground surface or in trenches. In that case, any unburned materials would have remained in the soil.

Contaminants in surface soil could infiltrate into subsurface soil during precipitation events. In general, the highest contaminant concentrations of explosives and metals are expected to be found in surface soil, with concentrations decreasing with increases in depth. In the case of perchlorates, which are highly

soluble in water, any releases of perchlorate would tend to move at the same rate as water moves through surface soil into the subsurface soil. However, in the case of the SIAD LBA unit, the rate of water movement would be relatively slow because of the low precipitation rate (approximately 6 inches per year) and high evaporation rate (approximately 40 inches per year).

8.1.2 Historical Investigations

The LBA soils have been sampled and analyzed during the following three previous investigations:

- October 1981 by the U.S. Army Environmental Health Agency (USAEHA) (1981).
- 1991 during the Group II RI performed by James M. Montgomery Consulting Engineers (JMM) (1992).
- 1999 during the Follow-On RI performed by Harding Environmental Science and Engineering (Harding ESE) (2001).

Following is a discussion of each of these investigations and conclusions based on the investigation results.

8.1.2.1 United States Army Environmental Health Agency Study

During the 1981 investigation, the USAEHA collected 12 surface soil samples and analyzed them for metals [using the Extraction Procedure (EP) Toxicity leaching procedure] and explosives. Table 8-1 lists all of the analytes for the LBA that were detected at least once in any sample. No record of these sample locations could be found. Extractable barium was detected in Sample 9 [38.4 milligrams per liter (mg/L)], and extractable lead was detected in Sample 12 (4.96 mg/L), but these concentrations did not exceed the EP Toxicity limits of 200 mg/L for barium and 5.0 mg/L for lead. HMX was detected in 5 of the 12 samples at low concentrations [1.9 to 4.4 milligrams per kilogram (mg/kg)], 2,6-DNT was detected in two samples (at 3.5 and 7.3 mg/kg), and RDX was detected in one sample at a low concentration (1.3 mg/kg).

8.1.2.2 Group II 1991 Remedial Investigation

During the Group II RI, a total of 20 composite surface (collected from 0 to 6 inches bgs) and 20 subsurface (collected from 6 to 12 inches bgs) soil samples were collected from 20 locations in the LBA (JMM, 1992). Each surface soil sample was collected at the nodes of four adjacent grid points, encompassing approximately a 100-foot-by-100-foot grid, and composited into one sample for analysis. Sample locations are shown on Figure 8-1. All samples were analyzed for Title 22 metals (silver, arsenic,

barium, beryllium, cadmium, cobalt, chromium, copper, molybdenum, mercury, nickel, lead, antimony, thallium, vanadium, zinc, and selenium) and explosives [1,3,5-trinitrobenzene (-TNB), TNT, 1,3-dinitrobenzene (DNB), 2,4-DNT, HMX, RDX, and nitrobenzene (NB)]. Background samples were also collected at the UBG as part of this investigation. All of the 17 Title 22 metals except silver, cobalt, arsenic, selenium, and vanadium were detected in excess of background levels in both the 0- to 6-inch interval and in the 6- to 12-inch intervals at the LBA in one or more samples. Figure 8-2 shows detections of metals at concentrations greater than background.

Lead was detected in excess of the background level of 15.7 micrograms per gram ($\mu\text{g/g}$) in 19 of 20, or 95 percent, of the composite samples collected from the 0- to 6-inch interval, and in 8 of 20, or 40 percent, of those collected from the 6- to 12-inch interval. The average concentrations detected were 912.0 and 39.4 $\mu\text{g/g}$ for the surface interval and the near-surface interval, respectively. Lead concentrations ranged from 8.1 to 11,500 $\mu\text{g/g}$. Two composite samples exceeded the TTLC for lead (1,000 $\mu\text{g/g}$). The Waste Extraction Test (WET) was performed on 18 composite samples to determine soluble lead concentrations. Soluble lead concentrations ranged from 166 to 4,180 micrograms per liter ($\mu\text{g/L}$); the STLC for lead is 5,000 $\mu\text{g/L}$.

Beryllium was detected in excess of the background level in only one sample, LBA-04-SC, of 40 (2.5 percent) at a concentration of 4.4 $\mu\text{g/g}$. This composite sample was collected from the 0- to 6-inch interval in the northeastern corner of the LBA. Beryllium was not detected at this site in the 6- to 12-inch interval. The average concentration detected in the 0- to 6-inch was 1.7 $\mu\text{g/g}$, which is less than the background level of 3.2 $\mu\text{g/g}$.

Low levels of mercury were detected in excess of the background level in 3 of 20 samples collected from the 0- to 6-inch interval and in only one of 20 samples collected from the 6- to 12-inch interval. The highest concentration detected was 0.20 $\mu\text{g/g}$ in the 0- to 6-inch interval in a sample located in the northwestern corner of the LBA. Due to the low concentrations of total mercury relative to the TTLC, no WETs were performed.

Antimony was detected in excess of the background level of 11.4 $\mu\text{g/g}$ in six samples collected from the surface interval and in one sample from the near-surface interval. The maximum concentration detected was 49.0 $\mu\text{g/g}$ in the near-surface interval. The average concentration for the 0- to 6-inch interval was 10.38 $\mu\text{g/g}$. Due to the low concentrations of antimony relative to the TTLC, no WETs were performed.

Explosive compounds were detected in 16 of the 40 composite soil samples collected at the LBA. Only three of these samples were from the 6- to 12-inch interval. The compounds detected in the LBA were 1,3,5-TNB, 2,4,6-TNT, 2,4-DNT, HMX, and RDX.

1,3,5-TNB was detected in 3 of 40 samples at concentrations ranging from 0.82 to 3.7 µg/g. All of these samples were collected from the 0- to 6-inch interval. The average value calculated for this compound in the 0- to 6-inch interval was 0.54 µg/g.

2,4,6-TNT was detected in 12 of 40 samples at concentrations ranging from 0.46 to 3.2 µg/g. Eleven of these samples were collected from the 0- to 6-inch interval. The average value calculated for the 0- to 6-inch interval was 0.63 µg/g.

2,4-DNT was detected in 7 of 40 samples at concentrations ranging from 0.53 to 3.75 µg/g. All of these samples were collected from the 0- to 6-inch interval. The average concentration calculated for this compound was 0.7 µg/g.

HMX was detected in only one sample in the Lower Burning Ground (LBG) at a concentration of 1.6 µg/g.

RDX was detected in 8 of 40 samples at concentrations ranging from 0.69 to 1.89 µg/g. Five of these samples were collected from the surface interval. The average value was calculated to be 0.67 µg/g for the surface interval and 0.54 µg/g for the near-surface interval.

A quantitative health risk assessment was conducted using the data from the 1991 RI. A concentration-toxicity screening process was conducted. Compounds detected greater than 5 percent of the time, possessed significant estimated carcinogenicity, and that contributed greater than 10 percent of the noncancer risk were carried into the quantitative portion of the risk assessment. These compounds included metals (mercury, barium, cadmium, and lead) and explosives (1,2,5-TNB, TNT, 2,4-DNT, and RDX). The health risk assessment considered three potential receptor categories including casual visitors, SIAD personnel working on a regular basis on the site, and potential future construction workers at the site. The potential future residential scenario was not used because it was not considered to be realistic. The risk level of 1×10^{-6} was considered to be a benchmark, with higher levels being considered significant. No significant risk was identified for any receptor at the LBA. An HI of 1.0 was considered to be the benchmark, with higher HIs being considered significant. The HI for the construction was 2.9, and HIs for other receptors were less than 1.

8.1.2.3 Follow-On Remedial Investigation

The purpose of the Follow-On RI conducted during 2000 was to complete the RI process and support an FS for eight areas at the UBG, including the LBA. The specific intent of the Follow-On RI was to: (1) assess the nature and extent of contaminants in soil and sediment that may exceed TTLCs or STLCs; (2) assess the nature and extent of contaminants in groundwater that may exceed Maximum Contaminant

Levels (MCLs); and (3) support informed risk management decisions. The field sampling program was designed to fill data gaps identified during Army and DTSC review of the Group II RI Report. State regulatory review of the Group II RI identified data gaps for the LBA related to the composite sampling strategy and the absence of surveyed soil sampling locations. As noted above, the Group II RI characterized the LBA using composite soil samples to identify general areas of potentially elevated metals concentrations. Because the samples were composted, specific areas that may contain elevated metal concentrations could not be identified. Additionally, the Group II RI composite sampling strategy did not yield data appropriate for a quantitative evaluation of potential risk. This data gap during the Follow-On RI was addressed by collecting discrete soil samples from locations suspected to contain generally elevated metals concentrations. Soil and sediment samples were analyzed for explosives and for total and soluble metals. California Title 22 metals were included in the metals analysis. Total metals were quantified through analysis of soil samples; soluble metals were quantified through analysis of California Waste Extraction Test (Cal-Wet) extracts. LBA soil samples were also analyzed for perchlorate.

During the Follow-On RI, background metals concentrations in soil and sediment were developed to provide a baseline for comparison with metals concentrations from the investigative samples. DTSC Guidance, Selecting Inorganic Constituents as Chemicals of Potential Concern for Risk Assessments at Hazardous Waste Sites and Permitted Facilities – Final Policy (1997), was used. Consistent with this policy, background comparisons were made to ambient metals concentrations rather than pristine area metals concentrations.

Field Program

Twelve 100-foot by-100-foot grids were established within the northeastern quadrant of the LBA for the Follow-On RI investigation. The outer corners were surveyed, and the remaining grid stake corners were located on 100-foot centers with a survey transit. Soil samples were collected within each grid at the approximate locations where Group II RI samples had indicated elevated metals concentrations. A total of 24 samples were collected at the 0- to 2-inch and 6- to 12-inch depths. Figure 8-3 shows these sample locations.

Analytical Results

As shown on Figure 8-3 and in Table 8-2, eight different explosive compounds were detected in the soil samples collected from the LBA in 1999. The greatest variety of explosive compounds was detected in surface samples LBA-SS-01, LBA-SS-03, and LBA-SS-08, which are all located on the northeastern side of the LBA. 2,4-DNT and 2,6-DNT were the only explosive compounds detected in soil and swale samples collected from the southern, central, and the western sides of the LBA, and these were detected

at relatively low concentrations (less than or equal to 1.49 mg/kg). Perchlorate was detected in only one sample (LBA-SS-06) at a concentration of 7.52 mg/kg.

Table 8-3 presents data for all samples in which concentrations of one or more of the metals analyzed exceeded ambient concentrations during the Follow-On RI. The metals that exceeded ambient concentrations in at least one sample included barium cadmium, copper, lead, mercury, molybdenum, selenium, silver, thallium, and zinc. Metals that were not detected in soil at concentrations exceeding ambient background concentrations included arsenic, antimony, beryllium, chromium, cobalt, nickel and vanadium.

Table 8-4 presents data for all drainage samples in which concentrations of one or more metals exceeded ambient concentrations during the Follow-On RI. The metals that exceeded ambient concentrations in at least one sample were antimony, barium, beryllium, chromium, copper, lead, thallium, vanadium, and zinc. Metals that were not detected at concentrations exceeding ambient background included arsenic, cadmium, cobalt, mercury, molybdenum, nickel, selenium, and silver.

Table 8-5 presents data for all soil and drainage samples exceeding TTLC or STLC values. Lead is the only analyte in the LBA that exceeded the TTLC value (1,000 mg/kg) in soil and sediment. Soil samples collected from the LBA were submitted for Cal-Wet extraction analysis. Lead in 11 soil sample extracts and cadmium in one sample extract were the only metals with concentrations that exceed corresponding STLC values (5 mg/L and 1 mg/L), respectively. Figure 8-4 shows the LBA soils and drainage/soil sediment samples locations and metal concentrations exceeding TTLC or STLC values.

Human Health Risk Assessment Methodology

The HHRA was conducted in a manner consistent with the DTSC Preliminary Risk Endangerment Assessment Guidance (1996). Receptors included current workers, future workers, and hypothetical future residents and construction workers. The risk assessment followed all DTSC guidance by including all analytes as COCs and assuming that chromium was present as hexavalent chromium (Cr VI) where Cr VI was not specifically analyzed. The exposure point concentrations for the reasonable maximum exposure (RME) scenario were either the maximum or the 95 percent upper confidence limit (UCL) of the arithmetic mean concentration detected in site media. If the calculated UCL was greater than the maximum detected concentration, the maximum value was used for exposure point concentration. For comparison, the potential risks were estimated for ambient background and statewide background concentrations of metals using the same procedures and assumptions. This approach identified a need to estimate an incremental risk related to site chemicals because all site-related and background risk values were greater than 1×10^{-6} , and HIs were often greater than 1.0. Table 8-6 lists the exposure point

concentrations used in the risk assessment for the LBA, ambient background concentrations, and California/Nevada statewide background concentrations.

The Follow-On RI characterized surface soil using a biased sampling strategy that sampled areas most likely to contain high metals concentrations. Drainage area soil, which is called sediment in the Follow-On RI, was considered to be equivalent to surface soil. The drainage areas are infrequently wet, resulting in potential exposures similar to soil exposure. The release of organics and metals from soil to groundwater was considered to be an unlikely pathway for the following reasons:

- Explosive compounds (organic chemicals) were infrequently detected in soil samples and had not been detected in groundwater samples.
- Advective flow of water through the unsaturated zone to groundwater is considered to be limited at SIAD due to the arid climate. Annual precipitation ranges from approximately 20 inches in the surrounding mountains to less than 5 inches on the Honey Lake Valley floor. In addition, evaporation rates have been measured to be as high as 0.4 inches per day during August 1996 (Varian, 1997). These evaporation rates greatly exceed precipitation rates, indicating that very little precipitation is available for infiltration and subsequent downward percolation to groundwater. In addition, the depth to groundwater at the UBG ranges from 18 feet at UBG-01-MWA to 75 feet at UBG-03-MWA (Subsection 2.2). Based on the limited amount of water available for downward percolation and the depth to groundwater, it is unlikely that available surface water will percolate from the unsaturated zone to the groundwater.
- The pH of the soil and groundwater in the UBG is approximately neutral (i.e., 6.5 to 7.5). Therefore, metals will not likely solubilize in the unsaturated zone.

Although it is unlikely that groundwater has been impacted by UBG activities, shallow groundwater was evaluated under a residential scenario in this risk assessment at the request of DTSC and the Regional Water Quality Control Board (RWQCB).

The surface water pathway was also considered unlikely for human exposure because there is no perennial surface water near the UBG. This release mechanism and transport medium is not expected to adversely impact distant surface water bodies such as Honey Lake.

Human Health Risk Assessment Results

The HI values were 0.004 for visitors, 0.4 for current workers, 0.9 for future workers, and 0.1 for construction workers. These HIs were not of concern for cancer effects. The HI for hypothetical

residential child receptors was 7 and may be of concern for noncancer effects. Ingestion of soil was the major intake route. The chemicals contributing the most were thallium [Hazard Quotient (HQ) = 1.6 representing 35 percent of the risk], iron (HQ = 1: representing 22 percent of the risk), and arsenic (HQ = 0.73: representing 16 percent of the risk). Risks related to exposure to ambient soil concentrations were estimated for future receptors (construction workers and residents). The HIs were 3.9 for residential receptors and 0.22 for future construction worker receptors. Risk related to statewide background concentrations were also estimated only for future receptors. The HIs related to statewide background concentrations were 5.6 for resident receptors and 1.1 for future construction worker receptors.

The risk estimate for visitors was 1.3×10^{-7} , which is less than DTSC's cancer screening level risk of 1×10^{-6} . The risk estimate for current workers is 1×10^{-5} . Inhalation of soil particulates is the major contributor to risk for the current worker (7.8×10^{-6}). The inhalation risk is a result of assuming trivalent chromium (Cr III) has the same carcinogenic potency as Cr VI by the inhalation route. Cr III contributes 94 percent of the inhalation risk. The upper bound cancer risk estimate for hypothetical residential receptors, representing a combined child and adult exposure is 8.1×10^{-5} . Soil ingestion contributes 4.0×10^{-5} , and inhalation contributes 3.8×10^{-5} . Arsenic contributes 99.5 percent of the risk (4.0×10^{-5}) by soil ingestion. Cr III contributes 94 percent of the risk (3.6×10^{-5}) by soil particulate inhalation. The cancer risk for potential future workers and construction workers is 2.5×10^{-5} and 2.9×10^{-6} , respectively.

The risks resulting from exposure to ambient background metals concentrations in soil were estimated for residual and future worker receptors. The cancer risk values were 1.3×10^{-4} for residential receptors and 3.9×10^{-5} for future worker receptors.

The risks related to exposure to statewide background metals concentrations in soil were estimated for residential and future worker receptors. The cancer risk values were 2.6×10^{-4} for residential receptors and 1.2×10^{-4} for future workers.

The 95 UCL blood lead levels for adult resident and worker receptors were less than California's target level of 10 micrograms per deciliter ($\mu\text{g}/\text{dL}$). The 95 UCL blood lead level for the hypothetical residential child receptor is greater than 10 $\mu\text{g}/\text{dL}$.

The risk assessment resulted in risk values and HIs greater than the DTSC screening level criteria of 1×10^{-6} and 1.0, respectively, for all areas of the site and for ambient and statewide background. These results make it difficult to support a risk management decision that is intended to be protective of human health and at the same time meet guidance that states it is not appropriate to clean sites to less than background risks/concentrations. One approach to producing more meaningful results is to account for background concentrations in the risk estimate. The DTSC recommends excluding a metal from the risk

calculation when the background concentration is greater than the site concentration and including the site concentration when the background concentration is less than the site concentration.

For this risk assessment, an alternative approach was proposed in which an estimate was developed for the incremental risk greater than background. In this approach, the background concentration was subtracted from the site concentration and the risk estimate was calculated based on the difference in concentration. If the background concentration was greater than the site concentration, zero was used as the site concentration.

The incremental concentrations used to estimate incremental risks are listed in Table 8-7.

The incremental HI values were: 0.0006 for visitors, 0.041 for current workers, 0.10 for future workers, 0.83 for hypothetical residential receptors, and 0.01 for construction workers. These HI values are not of concern for noncancer effects.

The results of the LBA Follow-On RI field activities are summarized below:

- Metal debris was observed in soil samples collected from this area.
- Metals frequently detected in soil samples at concentrations exceeding their respective ambient background concentrations included barium, copper, lead, and zinc.
- Total metal concentrations in the 24 soil samples collected from the LBA generally were less than their respective TTLC values, with the exception of lead in soil samples LBA-SS-10 and LBA-SS-12 (0- to 6-inch interval). Similarly, the metals concentrations in soil samples collected from the LBA during the Group II RI were generally less than their respective STLC values, with the exception of lead concentrations in two samples that exceeded the lead TTLC value.
- Soluble lead concentrations in 11 of the 12 soil samples collected from the 0- to 6-inch interval exceeded their respective STLC values. Soluble cadmium concentration in one soil sample exceeded its STLC value. The soluble metals concentrations in soil samples collected from the LBA during the Group II RI were less than their respective STLC values. The Group II RI soluble metals concentrations may be lower than the Follow-On RI soluble metals concentrations due to changes in soil chemistry or differences in laboratory performance of the Cal-Wet extraction. However, based on the concentrations of soluble metals in LBA soil, it appears that little vertical migration of metals from the surface to deeper intervals has occurred.

- Metals frequently detected in sediment samples at concentrations exceeding their respective ambient background concentrations included barium, lead, and zinc.
- Lead in 2 of the 20 sediment samples exceeded the lead TTLC values. These samples were collected from the 0- to 6-inch interval.
- Soluble lead concentration in four sediment samples collected from the 0- to 6-inch interval and one sediment sample collected from the 6- to 12-inch interval exceeded the STLC value. Because elevated soluble lead concentrations are present in drainages on the southern boundary of the area, the possibility for migration of metals off site exists.
- Eight explosives were infrequently detected (except for 2,4-DNT) in soil samples at concentrations generally less than 1 mg/kg. In sediment samples, only 2,4-DNT was detected. Perchlorate was detected in one soil sample at a concentration less than 10 mg/kg.

8.1.3 Locations and Depths of Proposed Soil Samples

The RI investigations at the LBA conducted in 1991 and 1999 established a baseline of data for concentrations of metals, explosives, and perchlorates in soil and the movement of these chemicals within the soil column. The 1999 investigation focused on only a portion of the LBA. Interim status OB operations took place throughout the LBA since 1991. These OB operations could have resulted in releases to the soil and drainages. Therefore, additional soil sampling is necessary to determine whether OB operations conducted since 1991 have resulted in contamination of soil and drainages.

The soil investigation for the closure of the LBA will be conducted in one or more rounds. The objective of the first round will be to confirm earlier studies as to whether soil contains significant quantities of contamination and to determine whether burning operations conducted since RI samples were collected have resulted in significant releases to soil and drainages. Therefore, Round 1 samples will be collected at locations where soil is most likely to have been impacted by contaminants released during or after OB operations. Sampling programs for subsequent rounds, if necessary, will be developed based on the results of the first round. If significant concentrations of contaminants are not found, no further rounds of sampling will be conducted. If significant concentrations of one or more contaminants are found, additional rounds of sampling will be conducted. The objective of subsequent rounds of sampling will be to determine the horizontal and vertical extent of contaminants detected during the first round of sampling.

During the first round of sampling, surface (0 to 6 inches bgs) and subsurface (2 to 3 feet bgs, 4 to 5 feet bgs, and 6 to 7 feet bgs) soil samples will be collected at 18 locations within the LBA where interim status

OB operations took place. Surface and near surface soil samples will be collected at 12 locations in drainages. The LBA samples to be collected are listed in Table 8-8. The sampling locations are shown on Figure 8-5. Soil samples will be collected at locations in a grid pattern similar to the pattern used in the 1991 RI field program. Drainageway samples will be collected in the same approximate locations as those in the Follow-On RI field program. Additional samples will be collected and analyzed during a Round 2 event if the results of Round 1 suggest that additional sampling and analyses are warranted to adequately characterize the nature and extent of contamination.

8.1.4 Analytical Program

Each soil sample collected from the LBA will be analyzed for the following:

- Explosives by SW 846 Method 8330
- Perchlorates by U.S. EPA Method 314.0 with confirmation of detections by SW 846 8321A
- Title 22 metals by SW 846 Method 6010B
- Dioxins by SW 846 Method 8290

Section 11.0 includes a detailed listing of the compounds that will be analyzed and examples of reporting limits. The laboratories performing the analyses will be certified by the State of California in accordance with Article 8.5 Section 25198 of the California Hazardous Waste Code and will follow QA requirements described in the latest edition of Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (U.S. EPA SW 846).

8.2 OD UNIT - ACTIVE DEMOLITION AREA

The ADA consists of 14 pits dug into the foothills of the Amedee Mountains (see Figure 1-3). The area encompassing the pits total approximately 30 acres. The pits were dug with sides ranging from a few feet to more than 30 feet at the pit back wall. The pits are sloped inward from the entrance toward the back of the pits to control run-on/runoff. No liners or structures were used in the pits. Figure 1-3 shows the layout and relative dimensions of the OD pits.

8.2.1 Conceptual Site Model

Contaminants could have been released to the soil from the ADA pits as the result of OD of military munitions/explosives and the OB of rocket motors.

Open Detonation: OD treatments only took place within the 14 pits. Explosives were arranged in munitions-specific configurations and overlain with donor charges. The configuration was designed to

direct the explosive force inward to the munitions. The blasts resulted in a plume that contained large quantities of particulate matter. The particulate matter consisted of dirt from the floors and walls of the pits, fragmented metal casings from the munitions items, and inorganic materials that were part of the explosive formulation, such as lead azide. The particles with the greatest density and largest mass tended to fall out in close proximity to the detonation points. As the distance from the detonation points increases, the expected concentrations of contaminants in surface soil should decrease. Most of the particulates from the plume were initially deposited onto surface soil within the pits and in close proximity to the pits. Therefore, the greatest concentrations of contaminants are expected to be found in the uppermost soil (i.e., 0 to 1 foot bgs). Mixtures of surface and subsurface soil took place as the result of the entrainment of the pit soils within the blast and subsequent redeposition. As a result, subsurface soil within the ADA pits may also contain significant concentrations of contaminants. Outside the pits, contamination of subsurface soil would only have taken place as the result of precipitation-induced infiltration of contaminants from surface soil. In general, the highest contaminant concentrations of explosives and metals would be expected to be found in surface soil, with concentrations decreasing with increases in depth and distance from the ADA pits.

Rocket Motors: OB of large rocket motors took place within the ADA pits. The rocket motors were laid on their sides and explosives charges used to crack the casing open and initiate burning of the propellant contained within the casing. The burning operation resulted in emission plumes. Little, if any, soil was entrained within the plumes because no detonations were involved and the propellants were contained within the rocket motor casing. Particulate matter in the plume consisted primarily of inorganic materials such as aluminum compounds (Al_2O_3) and chloride compounds. The greatest concentrations of contaminants in surface soil would be expected to be found within the pits and in close proximity to the pits. Outside the pits, contamination of subsurface soil would only have taken place as the result of precipitation-induced infiltration of contaminants from surface soil. As the distance from the pits increases, the expected concentrations of contaminants in surface soil would decrease.

8.2.2 Historical Investigations

Remedial investigations have not been conducted at the ADA. Soil samples were collected from the OD pits for purposes of hazardous waste classification during 1999. All samples were collected in accordance with the DTSC-approved Work Plan dated December 1998 (TtNUS, 1998).

Samples were tested for the following hazardous waste characteristics for selected constituents and the California Corrosivity Characteristics property:

- TC [22 CCR 66261.24(a)(1)]
- STLC [22 CCR 66261.24(a)(2)]

- TTLC [22 CCR 66261.24(a)(2)]
- California Corrosivity Characteristics [22 CCR 66261.22(a)(3)]

A total of 552 grab samples were collected from the OD pits that were then composited into 96 samples. All of these composited samples were analyzed for asbestos, barium, cadmium, copper, lead, nickel, and zinc for comparison to TTLC limits. Selected samples were tested for corrosivity.

The process described below was used to analyze samples. For the purpose of this discussion, "whole sample" indicates that all size fractions (fine and coarse) were tested, whereas for "fine fraction," only that portion of the sample less than 106 micrometers (μm) was tested.

1. Compositing: The four to six individual grab samples that made up one composite sample were combined to form a whole sample, as prescribed in ASTM Method D 6051-96.
2. TTLC: All composited whole samples were then analyzed for asbestos, barium, cadmium, copper, lead, nickel, and zinc for comparison to each constituent's TTLC. Macs Laboratories in Santa Clara, California conducted asbestos analyses.
3. STLC: Any sample for which one or more metal constituent was present at a concentration that exceeded 10 times the STLC concentration listed in 22 CCR 66261.24(a)(2)(A) Table II (listed in the Work Plan in Table 3-1 of the Field Sampling Plan) was then extracted using the WET Procedure detailed in 22 CCR 66261 Appendix II. The extractions were then analyzed for comparison to STLCs. If a whole sample result exceeded the TTLC limits, no STLC analysis was performed on the whole sample.
4. TC: Those samples found to have total lead, barium, or cadmium concentrations greater than 20 times the regulatory level listed in 22 CCR 66261.24(a)(1)(B) Table 1 (also presented in the Work Plan in Table 3-1 of the Field Sampling Plan) were then extracted using the Toxicity Characteristic Leaching Procedure (TCLP) defined in U.S. EPA SW 846. These samples were then analyzed for comparison to the TC threshold limit. TC testing was performed regardless of whether the sample was found to exceed TTLC limits.
5. Any whole sample with all concentrations less than the TTLC and/or STLC limits was classified as not hazardous for TTLC and/or STLC.
6. Any whole sample with one or more concentrations greater than the TTLC or STLC limits was sieved through a 106- μm sieve. To the extent practical, the DTSC sample preparation procedure

was followed. The fraction of fines was calculated, as was the percent moisture if the sample required drying to allow all of the fines to pass through the sieve.

7. TTLC analysis was performed on the fine fractions for all of the elemental metals tested in the whole sample (barium, cadmium, copper, lead, nickel, and zinc). The total metals concentrations for the fine samples were adjusted by multiplying the metals concentrations in the fines by the ratio of the weight of the fines to the weight of the whole sample to determine the concentration for the whole sample (including any moisture content). The adjusted concentrations were compared to TTLC regulatory limits. Any sample for which an adjusted concentration exceeded the TTLC limit was classified as TTLC hazardous for the metals constituent exceeding the TTLC limit.
8. The adjusted TTLC concentrations of the fine fractions were also used to determine if STLC testing was necessary for any metals. Those fine fraction samples for which STLC testing was necessary were extracted using the WET Procedure, and the extract was analyzed for the necessary metals. The STLC concentration for the fine fraction was then adjusted by multiplying by the ratio of the weight of the fine fraction to the whole sample, as above. Any sample for which an adjusted concentration exceeded the STLC limit was classified as STLC hazardous for the metal constituent exceeding the STLC limit.
9. Eighteen whole samples were analyzed for the corrosivity characteristic (pH testing).

None of the samples were classified as RCRA hazardous for the TC or as non-RCRA hazardous for the TTLC. One sample was characterized as non-RCRA hazardous for the STLC. No asbestos was detected. Results of all pH analysis were between 8 and 9 for all samples, well within the regulatory limits of 2 to 12.5.

8.2.3 Locations and Depths of Proposed Soil Samples

UXO clearance activities discussed in Section 6.0 and emergency treatments of military munitions still in storage at SIAD will require utilization of up to four of the pits for detonations. Therefore, no soil investigations will be conducted in the pits designated for treatment of UXO and emergency detonations, as described below. These are Pits 9, 10, 11, and 12, as shown in Figure 1-3. These pits are located at the eastern edge of the ADA pit location.

The soil investigation at the ADA unit will be conducted in two or more rounds. The first round will consist of sampling of areas most likely to have been impacted by releases from OD operations (i.e., in and immediately surrounding the blast pits). The objective of the first round will be to determine whether soil

contains significant quantities of contamination. Sampling programs for subsequent rounds will be developed based on the results of the first round. If significant concentrations of contaminants are not found, no further rounds of sampling will be conducted at ADA Pits 1, 2, 3, 4, 5, 6, 7, and 14. When Pits 9, 10, 11, and 12 are no longer required for UXO or emergency treatments, these pits and adjacent Pits 8 and 13 will be sampled. If significant concentrations of contaminants are not detected during Round 1, no further sampling will be conducted. If significant concentrations of one or more contaminants are detected at one or more pits, additional rounds of sampling will be conducted. The objective of subsequent rounds of sampling will be to determine the horizontal and vertical extent of contamination detected in the early rounds of sampling.

The initial round of sampling will focus on ADA Pits 1, 2, 3, 4, 5, 6, 7, and 14. No sampling will take place at Pits 8 or 13 because these pits are located next to the pits where OD treatments may take place during UXO clearance operations or if required for emergency detonations and these adjacent pits could be impacted by fallout from these detonations. A minimum of 42 locations will be sampled during Round 1 as follows:

- Immediately outside of each pit (eight locations)
- Front of each pit floor (eight locations)
- Back of each pit floor or the lowest point (eight locations)
- Top of back wall of each pit (eight locations)
- Locations between the pits (total of 10 locations)

A total of 126 samples, not including QA samples, will be collected during Round 1. These samples are listed in Table 8-9, and locations are shown on Figure 8-6. The locations were selected to provide information on areas of expected highest concentrations (outside, front, and back of pits) and on changes in concentrations with distance (top of back wall and 50 and 200 feet from top of back wall). During the first round of sampling, only surface (0 to 6 inches bgs) and subsurface (2 to 3 and 4 to 5 feet) soil samples will be collected and analyzed. The surface samples are expected to provide information on the highest concentration of contaminants. Subsurface samples will be collected to provide information regarding the migration of contaminants into the subsurface. As necessary to delineate contaminants during later rounds of sampling, subsurface concentrations will be investigated at locations and areas where Round 1 and 2 samples indicated elevated metals concentrations or the presence of explosive compounds.

8.2.4 Analytical Program

Each soil sample collected from the OD area (ADA) will be analyzed for the following compounds;

- Explosives by SW 846 Method 8330
- Perchlorates by U.S. EPA Method 314.0 with confirmation of detections by SW 846 8321A
- Title 22 metals by SW 846 Method 6010B
- Dioxins by SW 846 Method 8290
- Asbestos by U.S. EPA Region 1 Soil Screening Protocol

Section 11.0 includes a detailed listing of the constituents that will be analyzed and examples of reporting limits. The laboratories performing the analyses will be certified by the State of California in accordance with Article 8.5 Section 25198 of the California Hazardous Waste Code and will follow QA requirements described in the latest edition of Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (U.S. EPA SW 846).

8.2.5 Explosive Hazards

The ADA pits were used for the treatment of military ordnance/explosives. It is considered highly likely based on historical information that MEC is present in subsurface soil within the pits and in all locations where soil samples will be collected. MEC presents a significant explosive safety hazard; therefore, trained UXO specialists will be part of the sampling team. These specialists will use visual techniques to identify MEC on the surface. Instruments such as magnetometers will be used to determine whether MEC may be present in subsurface locations. If MEC is suspected to be present in subsurface locations, the sample locations will be moved. The OD surface area has significant concentrations of shrapnel, and the presence of the shrapnel may result in many magnetometer false positives. In some cases, it may not be possible to collect all of the planned samples.

8.3 UNEXPLODED ORDNANCE

SIAD has conducted several clearance operations for UXO ejected from the ADA pits. During these clearance operations, UXO has been found as far as several thousand feet away from the ADA pits.

8.3.1 Conceptual Site Model

Most of the UXO that has been found down range from the ADA pits was intact. The casings were not breached. Explosives contained within the casings were not exposed and would not have been released to soil. However, in some instances, the casings were not intact and explosives may have been released to soil.

8.3.2 Locations and Depths of Soil Samples

A total of 10 locations will be sampled during Round 1 (see Table 8-10). These locations will be selected in the field to provide information on areas where non-intact MEC has been found. Samples will be collected from surface soil (0 to 6 inches bgs) and near subsurface soil (6 to 12 inches bgs). A total of 20 samples not including QA samples will be collected. These samples will provide information as to whether soil has been contaminated with explosives at the specific locations where MEC was discovered.

8.3.3 Analytical Program

Each soil sample collected from the MEC locations will be analyzed for the following compounds;

- Explosives by SW 846 Method 8330
- Perchlorates by U.S. EPA Method 314.0 with confirmation of detections by SW 846 8321A

Section 11.0 includes a detailed listing of the explosive compounds that will be analyzed and examples of reporting limits. The laboratories performing the analyses will be certified by the State of California in accordance with Article 8.5 Section 25198 of the California Hazardous Waste Code and will follow quality assurance requirements described in the latest edition of Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (U.S. EPA SW 846).

8.4 BACKGROUND SAMPLES

During the Follow-On RI, an area was chosen west of the UBG to collect background soil samples and develop a background data set for ambient concentrations of metals in soil (Harding ESE, 2001). The area chosen for sample collection is shown on Figure 8-7. A total of 20 surface soil samples (0 to 6 inches bgs) and eight surface sediment samples were collected from this area and analyzed for total metals and extractable metals using the Cal-Wet extraction procedure (Harding ESE, 2001). This ambient soil data set will be used to represent ambient soil concentrations for the current Closure Investigation. The DTSC policy for establishing ambient concentrations of metals (1997) will be used to evaluate the ambient concentrations and to compare the ambient concentrations to the newly collected soil samples from the LBA and ADA.

8.5 FIELD SAMPLING PROCEDURES AND DOCUMENTATION

The field sampling plan, which describes the sampling and documentation procedures for the closure investigation, is included in the MMRP SI Work Plan.

TABLE 8-1

**SURFACE SOIL SAMPLING RESULTS
UBG-LOWER BURNING AREA
1981
SIERRA ARMY DEPOT
HERLONG, CALIFORNIA**

Analyte	1 Pit 1 0-2 in	2 Pit 1 2-10 in	3 Pit 2 0-3 in	4 Pit 2 4-10 in	5 Pit 3 0-3 in	6 Pit 3 4-11 in	7 Pit 4 0-2 in	8 Pit 4 3-11 in	9 Pit 5 0-3 in	10 Pit 5 4-9 in	11 Background	12 Drainage
EP TOXICITY FOR METALS (mg/L)												
Barium ⁽¹⁾	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	38.4	<10.0	<10.0	<10.0
Lead ⁽²⁾	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	4.96
EXPLOSIVES (µg/g)												
2,4-DNT	<1.0	<1.0	7.3	<1.0	<1.0	<1.0	3.5	<1.0	<1.0	<1.0	<1.0	<1.0
HMX	<1.0	<1.0	2.0	<1.0	<1.0	<1.0	4.4	<1.0	2.6	2.7	1.9	<1.0
RDX	<1.0	<1.0	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Source: Benioff, 1988

Only analytes detected in site samples are listed on the table. A less than sign (“<”) followed by the detection limit indicates that the analyte was not detected in the sample.

1 Barium EP limit is 200 mg/L.

2 Lead EP limit is 5 mg/L.

EP =

TABLE 8-2

**Table 4.23: Explosives and Perchlorate Detected in Soil and Sediment Samples, Lower Burning Area
Upper Burning Ground Follow-on Remedial Investigation, Sierra Army Depot**

Sample ID	Depth Interval (ft.bgs)	1,3,5- Trinitrobenzene (mg/kg)	2,4,6- Trinitrotoluene (mg/kg)	2,4- Dinitrotoluene (mg/kg)	2,6- Dinitrotoluene (mg/kg)	2-Amino-4,6- Dinitrotoluene (mg/kg)	4-Amino-2,6- Dinitrotoluene (mg/kg)	HMX (mg/kg)	RDX (mg/kg)	Perchlorate (mg/kg)
Lower Burning Area - Soil										
LBA-SS-01	0 - 0.5	0.0731 JP	0.0844 JP	0.185 JP	---	---	---	2.17	8.58	---
LBA-SS-01	0.5 - 1	---	---	---	---	---	---	0.130 JP	0.172 JP	---
LBA-SS-02	0 - 0.5	---	---	0.311	---	---	---	0.113 JP	0.162 JP	---
LBA-SS-03	0 - 0.5	1.12	---	1.18	---	0.0905 JP	0.126 JP	0.174 JP	0.102 JP	---
LBA-SS-04	0 - 0.5	0.0772 JP	---	0.630	---	---	---	---	---	---
LBA-SS-04	0.5 - 1	---	---	0.741 JP	---	---	---	---	---	---
LBA-SS-06	0 - 0.5	---	---	0.0723 JP	---	---	---	---	---	---
LBA-SS-06	0 - 0.5	---	---	---	---	---	---	---	---	7.52
LBA-SS-07	0 - 0.5	---	---	0.121 JP	---	---	---	---	---	---
LBA-SS-08	0 - 0.5	0.0478 JP	---	0.0952 JP	---	---	---	0.0661 JP	0.0650 JP	---
LBA-SS-09	0 - 0.5	---	---	1.49	0.279	---	---	---	---	---
LBA-SS-09	0.5 - 1	---	---	0.230	---	---	---	---	---	---
LBA-SS-10	0 - 0.5	---	---	0.240	---	---	---	---	---	---

ft.bgs feet below ground surface
mg/kg milligrams per kilogram

J - Indicates an estimated value

P - Result less than reporting limit, but greater than the instrument detection limit

Source: (Harding ESE, 2001)

TABLE 8-2

**Table 4.23: Explosives and Perchlorate Detected in Soil and Sediment Samples, Lower Burning Area
Upper Burning Ground Follow-on Remedial Investigation, Sierra Army Depot**

Sample ID	Depth Interval (ft.bgs)	1,3,5- Trinitrobenzene (mg/kg)	2,4,6- Trinitrotoluene (mg/kg)	2,4- Dinitrotoluene (mg/kg)	2,6- Dinitrotoluene (mg/kg)	2-Amino-4,6- Dinitrotoluene (mg/kg)	4-Amino-2,6- Dinitrotoluene (mg/kg)	HMX (mg/kg)	RDX (mg/kg)	Perchlorate (mg/kg)
Lower Burning Area - Soil										
LBA-SS-10	0.5 - 1	---	---	0.0610 JP	---	---	---	---	---	---
LBA-SS-11	0 - 0.5	---	---	0.381	---	---	---	---	---	---
LBA-SS-12	0 - 0.5	---	---	0.618	---	---	---	---	---	---
Lower Burning Area - Drainages										
LBA-DR-03	0 - 0.5	---	---	0.139 JP	---	---	---	---	---	---
LBA-DR-04	0 - 0.5	---	---	0.0727 JP	---	---	---	---	---	---
LBA-DR-05	0 - 0.5	---	---	1.24	---	---	---	---	---	---
LBA-DR-06	0 - 0.5	---	---	0.0921 JP	---	---	---	---	---	---
LBA-DR-07	0 - 0.5	---	---	0.277	---	---	---	---	---	---

ft.bgs feet below ground surface
mg/kg milligrams per kilogram

J - Indicates an estimated value
P - Result less than reporting limit, but greater than the instrument detection limit

Source: (Harding ESE, 2001)

TABLE 8-3

Table 4.20: Metals Exceeding Ambient Concentrations - Soil Samples, Lower Burning Area Upper Burning Ground Follow-on Remedial Investigation, Sierra Army Depot

Sample ID	Depth Interval (ft.bgs)	Barium (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Thallium (mg/kg)	Zinc (mg/kg)
LBA-SS-01	0 - 0.5	2,560	---	136	340	---	---	---	---	---	370
LBA-SS-01	0.5 - 1	655	---	---	---	---	4.75 JP	---	---	---	163
LBA-SS-02	0 - 0.5	1,060	---	66.8	262	---	---	---	---	---	279
LBA-SS-02	0.5 - 1	529	---	---	---	---	---	---	---	---	---
LBA-SS-03	0 - 0.5	1,270	---	---	147	---	---	---	---	---	228
LBA-SS-04	0 - 0.5	1,650	---	---	545	---	---	---	---	---	285
LBA-SS-04	0.5 - 1	759	---	204	443	---	---	---	---	---	117
LBA-SS-05	0 - 0.5	584	---	---	---	---	---	---	---	---	---
LBA-SS-05	0.5 - 1	597	---	---	---	---	5.57 JP	---	---	---	---
LBA-SS-06	0 - 0.5	568	---	---	181	---	---	---	---	9.44 JP	---
LBA-SS-07	0 - 0.5	---	---	---	324	---	---	---	---	---	485
LBA-SS-07	0.5 - 1	492	---	---	---	---	---	---	---	12.0 JP	---
LBA-SS-08	0 - 0.5	812	---	62.7	219	---	---	---	---	---	164
LBA-SS-08	0.5 - 1	475	---	---	---	---	---	---	---	---	---
LBA-SS-09	0 - 0.5	2,410	41.7	262	525	---	---	18.4 JP	2.76	12.0 JP	861

ft.bgs feet below ground surface
mg/kg milligrams per kilogram

J - Indicates an estimated value
P - Result less than reporting limit, but greater than the instrument detection limit

TABLE 8-3

**Table 4.20: Metals Exceeding Ambient Concentrations - Soil Samples, Lower Burning Area
Upper Burning Ground Follow-on Remedial Investigation, Sierra Army Depot**

Sample ID	Depth Interval (ft.bgs)	Barium (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Thallium (mg/kg)	Zinc (mg/kg)
LBA-SS-09	0.5 - 1	663	---	---	---	---	---	---	---	---	---
LBA-SS-10	0 - 0.5	1,570	---	339	1,110	---	---	---	---	---	561
LBA-SS-10	0.5 - 1	673	---	---	---	---	---	---	---	---	196
LBA-SS-11	0 - 0.5	638	---	137	---	---	---	---	---	---	165
LBA-SS-11	0.5 - 1	511	---	---	---	---	---	---	---	---	---
LBA-SS-12	0 - 0.5	1,730	---	94.7	3,320	---	---	---	---	---	704
LBA-SS-12	0 - 0.5	---	---	---	---	0.164	---	---	---	---	---
LBA-SS-12	0.5 - 1	535	---	---	---	---	---	---	---	---	---

ft.bgs feet below ground surface
mg/kg milligrams per kilogram

J - Indicates an estimated value

P - Result less than reporting limit, but greater than the instrument detection limit

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Thursday, April 26, 2001

Source: (Harding ESE, 2001)

TABLE 8-4

**Table 4.21: Metals Exceeding Ambient Concentrations - Drainage Samples, Lower Burning Area
Upper Burning Ground Follow-on Remedial Investigation, Sierra Army Depot**

Sample ID	Depth Interval (ft.bgs)	Antimony (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Copper (mg/kg)	Hexavalent Chromium (mg/kg)	Lead (mg/kg)	Thallium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)
LBA-DR-01	0 - 0.5	8.53	497	---	---	---	1,230	---	---	129
LBA-DR-02	0 - 0.5	---	1,010	---	---	---	274	---	---	108
LBA-DR-03	0 - 0.5	---	636	---	---	---	111	---	---	152
LBA-DR-03	0.5 - 1	---	559	---	---	---	398	---	---	---
LBA-DR-04	0 - 0.5	---	976	---	---	---	---	---	---	181
LBA-DR-05	0 - 0.5	---	481	---	68.9	---	1,780	16.5 JP	---	120
LBA-DR-06	0 - 0.5	---	526	---	---	---	---	11.0 JP	---	---
LBA-DR-07	0.5 - 1	8.11 JP	---	---	---	---	---	---	---	---
LBA-DR-08	0 - 0	---	521	0.757	56.6	9.06	---	---	---	142
LBA-DR-09	0 - 0	9.06	---	---	---	1.05	---	9.94 JP	---	---
LBA-DR-10	0 - 0	---	---	---	---	1.72	---	---	---	---
LBA-DR-11	0 - 0	---	---	---	---	5.95	---	---	---	---
LBA-DR-12	0 - 0	---	473	---	---	4.79	---	---	---	---
LBA-DR-13	0 - 0	11.6	---	---	---	---	---	---	135	---

ft.bgs feet below ground surface
mg/kg milligrams per kilogram

J - Indicates an estimated value

P - Result less than reporting limit, but greater than the instrument detection limit

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Thursday, April 26, 2001

Harding Lawson Associates

Source: (Harding ESE, 2001)

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TABLE -5

Table 4.22: Metal Concentrations Exceeding TTLC or STLC Values, Lower Burning Area
Upper Burning Ground Follow-on Remedial Investigation, Sierra Army Depot

	Sample ID	Depth Interval	Units of Measure	TTLC (mg/kg)/ STLC (mg/l)	Cadmium	Lead
Value Exceeding TTLC						
Lower Burning Area - Drainages	LBA-DR-01	0-0.5	mg/kg	1000	---	1,230
	LBA-DR-05	0-0.5	mg/kg	1000	---	1,780
Lower Burning Area - Soil	LBA-SS-10	0-0.5	mg/kg	1000	---	1,110
	LBA-SS-12	0-0.5	mg/kg	1000	---	3,320
Value Exceeding STLC						
Lower Burning Area - Drainages	LBA-DR-01	0-0.5	mg/l	5	---	44.2
	LBA-DR-02	0-0.5	mg/l	5	---	15.5
	LBA-DR-03	0-0.5	mg/l	5	---	10.6
	LBA-DR-03	0.5-1	mg/l	5	---	6.74
	LBA-DR-05	0-0.5	mg/l	5	---	8.94
Lower Burning Area - Soil	LBA-SS-01	0-0.5	mg/l	5	---	25.9 J
	LBA-SS-02	0-0.5	mg/l	5	---	24.6 J
	LBA-SS-03	0-0.5	mg/l	5	---	9.52 J
	LBA-SS-04	0-0.5	mg/l	5	---	40.1 J
	LBA-SS-06	0-0.5	mg/l	5	---	6.81 J
	LBA-SS-07	0-0.5	mg/l	5	---	9.45 J
	LBA-SS-08	0-0.5	mg/l	5	---	14.7 J
	LBA-SS-09	0-0.5	mg/l	1	1.78	---
	LBA-SS-09	0-0.5	mg/l	5	---	56.4 J
	LBA-SS-10	0-0.5	mg/l	5	---	93.4 J
	LBA-SS-11	0-0.5	mg/l	5	---	6.34 J
	LBA-SS-12	0-0.5	mg/l	5	---	100 J

ug/g Micrograms per gram
mg/l Milligrams per liter
STLC Soluble Threshold Limit Concentration
TTLC Total Threshold Limit Concentration

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Source: (Harding ESE, 2001)

TAB E 8-6

**Table 5.3: Chemical Concentrations Used in the Risk Assessment
Upper Burning Ground, Sierra Army Depot**

Chemical	Old Demolition Area	Open Trenches and Ash Pile	Northern Extension	Southern Extension	Lower Burning Area	Ambient Background 95 UCL ^b	State Wide Background
1,3,5-Trinitrobenzene	0.072	0.040	0.041	0.041	0.118		
1,3-Dinitrobenzene	0.042	0.042	0.042	0.042	0.042		
2,4,6-Trinitrotoluene	1.61	0.082	0.113	0.128	0.082		
2,4-Dinitrotoluene	0.113	0.051	0.069	0.053	0.307		
2,6-Dinitrotoluene	0.094	0.110	0.110	0.108	0.121		
2-Amino-4,6-Dinitrotoluene	0.173	0.067	0.067	0.078	0.069		
2-Nitrotoluene	0.150	0.150	0.150	0.151	0.125		
3-Nitrotoluene	0.229	0.229	0.229	0.229	0.229		
4-Amino-2,6-Dinitrotoluene	0.181	0.112	0.112	0.145	0.113		
4-Nitrotoluene	0.229	0.229	0.229	0.241	0.229		
Aluminum	28,075	21,505	26,968	24,713	19,465	22,341	77,657
Antimony	7.30	96.20	7.02	6.79	6.60	6.46 ^a	1.11
Arsenic	12.5	22.1	17.6	14.1	17.0	14.37	8.63
Barium	404	1,990	333	485	892	321	799
Beryllium	0.620	0.297	0.556	0.507	0.415	0.46	1.40
Cadmium	6.87	4.51	1.39	3.05	3.53	2.39	
Calcium	23,132	45,537	33,854	19,459	30,517		
Chromium III	21.9	32.80	21.40	20.80	16.20	15.4	110
Chromium VI	---	1.27	8.38	---	---		
Cobalt	17.6	12.40	16.50	15.80	14.20	14.2	12.8
Copper	1,760	3,180	108	261	78.1	29.7	46.0
HMX	0.045	0.037	0.041	0.085	0.192		
Iron	45,408	28,006	29,028	30,892	23,851	28,982	
Lead	76.8	11,300	30.7	266	471	32.5	32.3
Magnesium	7,396	8,277	7,706	6,253	6,349		
Manganese	659	443	667	625	634	599	628
Mercury	2.06	0.038	0.057	0.104	0.092	0.06	0.16
Molybdenum	3.80	3.80	3.80	3.80	4.07		
Nickel	24.0	24.00	16.10	16.7	11.8	13.6	34.1
Nitrobenzene	0.056	0.342	0.140	0.056	0.056		
Perchlorate	---	---	---	---	0.853		
Potassium	2,656	4,281	6,442	5,174	4,912		
RDX (Cyclonite)	0.150	0.169	0.323	0.076	0.625		
Selenium	15.0	15.0	15.0	15.0	15.20	15 ^a	0.33
Silver	9.32	2.25	1.19	1.89	1.43	1.28	
Sodium	1,299	1,676	1,042	934	1,205		
Tetryl	2.11	0.407	3.07	0.178	0.067		
Thallium	9.68	8.90	9.00	9.57	10.1	8.9 ^a	
Vanadium	106	74.7	97.4	88.8	79.9	88.0	116
Zinc	995	1,328	232	3,462	218	66.2	78.6

Concentrations are the 95 percent upper confidence level of the arithmetic mean.

The concentration units are milligrams/kilogram (mg/kg).

a. The ambient background concentration is the detection limit.

b. The 95 UCL was calculated using all data used to estimate the 99 percentile ambient concentration.

Source: (Harding ESE, 2001)

TABLE 8-7

Table 5.8: Chemical Concentrations Used to Estimate Incremental Risk
Upper Burning Ground, Sierra Army Depot

Chemical	Soil				
	Old Demolition Area	Open Trenches and Ash Pile	Northern Extension	Southern Extension	Lower Burning Area
1,1,2-Trichloroethane	---	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---	---
1,2-Dinitrobenzene	---	---	---	---	---
2-(2-N-Butoxyethoxy)ethanol	---	---	---	---	---
1,3,5-Trinitrobenzene	0.072	0.040	0.041	0.041	0.118
1,3-Dinitrobenzene	0.042	0.042	0.042	0.042	0.042
2,4,6-Trinitrotoluene	1.61	0.082	0.113	0.128	0.082
2,4-Dinitrotoluene	0.113	0.051	0.069	0.053	0.307
2,6-Dinitrotoluene	0.094	0.110	0.110	0.108	0.121
2-Amino-4,6-Dinitrotoluene	0.173	0.067	0.067	0.078	0.069
2-Nitrotoluene	0.150	0.150	0.150	0.151	0.125
3-Nitrotoluene	0.229	0.229	0.229	0.229	0.229
4-Amino-2,6-Dinitrotoluene	0.181	0.112	0.112	0.145	0.113
4-Nitrotoluene	0.229	0.229	0.229	0.241	0.229
Aluminum	5,734	0	4,627	2,372	0
Antimony	0.84	89.74	0.56	0.33	0.14
Arsenic	0.0	7.73	3.2	0.0	2.6
Barium	83.39	1,669	12	164	571
Beryllium	0.161	0	0.097	0.048	0
Cadmium	4.48	2.12	0.00	0.66	1.14
Calcium	23,132	45,537	33,854	19,459	30,517
Chromium III	6.5	17.36	5.96	5.36	0.76
Chromium VI	---	1.27	8.38	---	---
Cobalt	3.4	0.00	2.31	1.61	0.01
Copper	1,730.34	3,150	78	231	48.4
HMX	0.045	0.037	0.041	0.085	0.192
Iron	16,426	0	46	1,910	0
Lead	44.3	11,268	0.0	234	439
Magnesium	7,396	8,277	7,706	6,253	6,349
Manganese	60	0	68	26	35
Mercury	2.00	0	0	0.042	0.030
Molybdenum	3.80	3.80	3.80	3.80	4.07
Nickel	10.4	10.42	2.52	3.1	0.0
Nitrobenzene	0.056	0.342	0.140	0.056	0.056
Perchlorate	---	---	---	---	0.853
Potassium	2,656	4,281	6,442	5,174	4,912
RDX (Cyclonite)	0.150	0.169	0.323	0.076	0.625
Selenium	0.0	0.0	0.0	0.0	0.20
Silver	8.04	0.97	0.00	0.61	0.15
Sodium	1,299	1,676	1,042	934	1,205
Tetryl	2.11	0.407	3.07	0.178	0.067
Thallium	0.78	0.00	0.10	0.67	1.2
Vanadium	18	0.0	9.4	0.8	0.0
Zinc	929	1,262	166	3,396	152

Concentrations are the 95 UCL for the area minus the 95 UCL of ambient background.
The concentration units are milligrams/kilogram (mg/kg).

TABLE 8-8

LISTING OF SURFACE AND SUBSURFACE SOIL SAMPLES AND LABORATORY ANALYSES⁽¹⁾
LOWER BURNING AREA (LBA)
SIERRA ARMY DEPOT
HERLONG, CALIFORNIA

Sample Location	Sample Number	Energetics		Metals Title 22 SW-846 Method 6010B
		Nitroaromatics / Nitramines SW 846 Method 8330	Perchlorate SW 846 6850 ⁽²⁾	
LBA-013	LBA-013-SS	1	1	1
	LBA-013-SB-0203	1	1	1
	LBA-013-SB-0405	1	1	1
	LBA-013-SB-0607	1	1	1
LBA-014	LBA-014-SS	1	1	1
	LBA-014-SB-0203	1	1	1
	LBA-014-SB-0405	1	1	1
	LBA-014-SB-0607	1	1	1
LBA-015	LBA-015-SS	1	1	1
	LBA-015-SB-0203	1	1	1
	LBA-015-SB-0405	1	1	1
	LBA-015-SB-0607	1	1	1
LBA-016	LBA-016-SS	1	1	1
	LBA-016-SB-0203	1	1	1
	LBA-016-SB-0405	1	1	1
	LBA-016-SB-0607	1	1	1
LBA-017	LBA-017-SS	1	1	1
	LBA-017-SB-0203	1	1	1
	LBA-017-SB-0405	1	1	1
	LBA-017-SB-0607	1	1	1
LBA-018	LBA-018-SS	1	1	1
	LBA-018-SB-0203	1	1	1
	LBA-018-SB-0405	1	1	1
	LBA-018-SB-0607	1	1	1
LBA-019	LBA-019-SS	1	1	1
	LBA-019-SB-0203	1	1	1
	LBA-019-SB-00405	1	1	1
	LBA-019-SB-00607	1	1	1
LBA-020	LBA-020-SS	1	1	1
	LBA-020-SB-0203	1	1	1
	LBA-020-SB-0405	1	1	1
	LBA-020-SB-0607	1	1	1
LBA-021	LBA-021-SS	1	1	1
	LBA-021-SB-0203	1	1	1
	LBA-021-SB-0405	1	1	1
	LBA-021-SB-0607	1	1	1
LBA-022	LBA-022-SS	1	1	1
	LBA-022-SB-0203	1	1	1
	LBA-022-SB-0405	1	1	1
	LBA-022-SB-0607	1	1	1
LBA-023	LBA-023-SS	1	1	1
	LBA-023-SB-0203	1	1	1
	LBA-023-SB-0405	1	1	1
	LBA-023-SB-0607	1	1	1
LBA-024	LBA-024-SS	1	1	1
	LBA-024-SB-0203	1	1	1
	LBA-024-SB-0405	1	1	1
	LBA-024-SB-0607	1	1	1
LBA-025	LBA-025-SS	1	1	1
	LBA-025-SB-0203	1	1	1
	LBA-025-SB-0405	1	1	1
	LBA-025-SB-0607	1	1	1

TABLE 8-8

LISTING OF SURFACE AND SUBSURFACE SOIL SAMPLES AND LABORATORY ANALYSES⁽¹⁾
LOWER BURNING AREA (LBA)
SIERRA ARMY DEPOT
HERLONG, CALIFORNIA

Sample Location	Sample Number	Energetics		Metals
		Nitroaromatics / Nitramines SW 846 Method 8330	Perchlorate SW 846 6850 ⁽²⁾	Title 22 SW-846 Method 6010B
LBA-026	LBA-026-SS	1	1	1
	LBA-026-SB-0203	1	1	1
	LBA-026-SB-0405	1	1	1
	LBA-026-SB-0607	1	1	1
LBA-027	LBA-027-SS	1	1	1
	LBA-027-SB-0203	1	1	1
	LBA-027-SB-0405	1	1	1
	LBA-027-SB-0607	1	1	1
LBA-028	LBA-028-SS	1	1	1
	LBA-028-SB-0203	1	1	1
	LBA-028-SB-0405	1	1	1
	LBA-028-SB-0607	1	1	1
LBA-029	LBA-029-SS	1	1	1
	LBA-029-SB-0203	1	1	1
	LBA-029-SB-0405	1	1	1
	LBA-029-SB-0607	1	1	1
LBA-030	LBA-030-SS	1	1	1
	LBA-030-SB-0203	1	1	1
	LBA-030-SB-0405	1	1	1
	LBA-030-SB-0607	1	1	1
NA	Field Duplicates ⁽³⁾	4	4	4
NA	Trip Blanks ⁽⁴⁾	NA	NA	NA
NA	Rinsate Blanks ⁽⁵⁾	NA	NA	NA
NA	Ambient Condition Blanks ⁽⁶⁾	1	1	1
NA	Matrix Spikes ⁽⁷⁾	4	4	4
NA	Matrix Spike Duplicates ⁽⁸⁾	4	4	NA
Surface and Subsurface Soil and Quality Control Samples		85	85	81

1 See Section 11 of this Closure Plan for specific analysis requirements and analyte lists.

2 Identified by DoD Perchlorate Policy.

3 Field duplicates will be collected at a frequency of 1 per every 20 environmental samples (minimum of 1 field duplicate per fraction).

4 Trip blanks will not be collected because they are only collected for volatile analysis.

5 Environmental samples will be collected by directly filling the sample bottle and/or use of a disposable plastic trowel; therefore, no rinsate blanks are required for this matrix.

6 Ambient condition blanks are optional samples that may be collected based on the judgment of the Field Operations Leader.

7 Matrix spikes are collected for all organic and inorganic parameters at a frequency of 1 per every 20 field samples per matrix.

8 Matrix spike duplicates are collected for all organic parameters. Laboratory duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of 1 per every 20 field samples per matrix per fraction.

Note* SS denotes a surface soil sample to be collected at a depth up to 6 inches below ground surface, and SB denotes a subsurface sample to be collected at the depth (in feet) as indicated by the last four digits of the sample number.

NA — Not applicable.

TABLE 8-9

LISTING OF SURFACE AND SUBSURFACE SOIL SAMPLES AND LABORATORY ANALYSES⁽⁴⁾
ACTIVE DETONATION AREA (ADA)
SIERRA ARMY DEPOT
HERLONG, CALIFORNIA
PAGE 1 OF 4

Sample Location	Sample Number	Energetics		Metals	Asbestos
		Nitroaromatics / Nitramines SW 846 Method 8330	Perchlorate SW 846 6850 ⁽²⁾	Title 22 SW-846 Method 6010B	U.S. EPA Region 1 Soil Screening Protocol
ADA-012	ADA-012-SS	1	1	1	1
	ADA-012-SB-0203	1	1	1	1
	ADA-012-SB-0305	1	1	1	1
ADA-013	ADA-013-SS	1	1	1	1
	ADA-013-SB-0203	1	1	1	1
	ADA-013-SB-0305	1	1	1	1
ADA-014	ADA-014-SS	1	1	1	1
	ADA-014-SB-0203	1	1	1	1
	ADA-014-SB-0305	1	1	1	1
ADA-015	ADA-015-SS	1	1	1	1
	ADA-015-SB-0203	1	1	1	1
	ADA-015-SB-0305	1	1	1	1
ADA-016	ADA-016-SS	1	1	1	1
	ADA-016-SB-0203	1	1	1	1
	ADA-016-SB-0305	1	1	1	1
ADA-017	ADA-017-SS	1	1	1	1
	ADA-017-SB-0203	1	1	1	1
	ADA-017-SB-0305	1	1	1	1
ADA-018	ADA-018-SS	1	1	1	1
	ADA-018-SB-0203	1	1	1	1
	ADA-018-SB-0305	1	1	1	1
ADA-019	ADA-019-SS	1	1	1	1
	ADA-019-SB-0203	1	1	1	1
	ADA-019-SB-0305	1	1	1	1
ADA-020	ADA-020-SS	1	1	1	1
	ADA-020-SB-0203	1	1	1	1
	ADA-020-SB-0305	1	1	1	1
ADA-021	ADA-021-SS	1	1	1	1
	ADA-021-SB-0203	1	1	1	1
	ADA-021-SB-0305	1	1	1	1
ADA-022	ADA-022-SS	1	1	1	1
	ADA-022-SB-0203	1	1	1	1
	ADA-022-SB-0305	1	1	1	1
ADA-023	ADA-023-SS	1	1	1	1
	ADA-023-SB-0203	1	1	1	1
	ADA-023-SB-0305	1	1	1	1
ADA-024	ADA-024-SS	1	1	1	1
	ADA-024-SB-0203	1	1	1	1
	ADA-024-SB-0305	1	1	1	1
ADA-025	ADA-025-SS	1	1	1	1
	ADA-025-SB-0203	1	1	1	1
	ADA-025-SB-0305	1	1	1	1

TABLE 8-9

LISTING OF SURFACE AND SUBSURFACE SOIL SAMPLES AND LABORATORY ANALYSES⁽⁴⁾
ACTIVE DETONATION AREA (ADA)
SIERRA ARMY DEPOT
HERLONG, CALIFORNIA
PAGE 2 OF 4

Sample Location	Sample Number	Energetics		Metals	Asbestos
		Nitroaromatics / Nitramines SW 846 Method 8330	Perchlorate SW 846 6850 ⁽²⁾	Title 22 SW-846 Method 6010B	U.S. EPA Region 1 Soil Screening Protocol
ADA-026	ADA-026-SS	1	1	1	1
	ADA-026-SB-0203	1	1	1	1
	ADA-026-SB-0305	1	1	1	1
ADA-027	ADA-027-SS	1	1	1	1
	ADA-027-SB-0203	1	1	1	1
	ADA-027-SB-0305	1	1	1	1
ADA-028	ADA-028-SS	1	1	1	1
	ADA-028-SB-0203	1	1	1	1
	ADA-028-SB-0305	1	1	1	1
ADA-029	ADA-029-SS	1	1	1	1
	ADA-029-SB-0203	1	1	1	1
	ADA-029-SB-0305	1	1	1	1
ADA-030	ADA-030-SS	1	1	1	1
	ADA-030-SB-0203	1	1	1	1
	ADA-030-SB-0305	1	1	1	1
ADA-031	ADA-031-SS	1	1	1	1
	ADA-031-SB-0203	1	1	1	1
	ADA-031-SB-0305	1	1	1	1
ADA-032	ADA-032-SS	1	1	1	1
	ADA-032-SB-0203	1	1	1	1
	ADA-032-SB-0305	1	1	1	1
ADA-033	ADA-033-SS	1	1	1	1
	ADA-033-SB-0203	1	1	1	1
	ADA-033-SB-0305	1	1	1	1
ADA-034	ADA-034-SS	1	1	1	1
	ADA-034-SB-0203	1	1	1	1
	ADA-034-SB-0305	1	1	1	1
ADA-035	ADA-035-SS	1	1	1	1
	ADA-035-SB-0203	1	1	1	1
	ADA-035-SB-0305	1	1	1	1
ADA-036	ADA-036-SS	1	1	1	1
	ADA-036-SB-0203	1	1	1	1
	ADA-036-SB-0305	1	1	1	1
ADA-037	ADA-037-SS	1	1	1	1
	ADA-037-SB-0203	1	1	1	1
	ADA-037-SB-0305	1	1	1	1
ADA-038	ADA-038-SS	1	1	1	1
	ADA-038-SB-0203	1	1	1	1
	ADA-038-SB-0305	1	1	1	1
ADA-039	ADA-039-SS	1	1	1	1
	ADA-039-SB-0203	1	1	1	1
	ADA-039-SB-0305	1	1	1	1

TABLE 8-9

LISTING OF SURFACE AND SUBSURFACE SOIL SAMPLES AND LABORATORY ANALYSES⁽⁴⁾
ACTIVE DETONATION AREA (ADA)
SIERRA ARMY DEPOT
HERLONG, CALIFORNIA
PAGE 3 OF 4

Sample Location	Sample Number	Energetics		Metals	Asbestos
		Nitroaromatics / Nitramines SW 846 Method 8330	Perchlorate SW 846 6850 ⁽²⁾	Title 22 SW-846 Method 6010B	U.S. EPA Region 1 Soil Screening Protocol
ADA-040	ADA-040-SS	1	1	1	1
	ADA-040-SB-0203	1	1	1	1
	ADA-040-SB-0305	1	1	1	1
ADA-041	ADA-041-SS	1	1	1	1
	ADA-041-SB-0203	1	1	1	1
	ADA-041-SB-0305	1	1	1	1
ADA-042	ADA-042-SS	1	1	1	1
	ADA-042-SB-0203	1	1	1	1
	ADA-042-SB-0305	1	1	1	1
ADA-043	ADA-043-SS	1	1	1	1
	ADA-043-SB-0203	1	1	1	1
	ADA-043-SB-0305	1	1	1	1
ADA-044	ADA-044-SS	1	1	1	1
	ADA-044-SB-0203	1	1	1	1
	ADA-044-SB-0305	1	1	1	1
ADA-045	ADA-045-SS	1	1	1	1
	ADA-045-SB-0203	1	1	1	1
	ADA-045-SB-0305	1	1	1	1
ADA-046	ADA-046-SS	1	1	1	1
	ADA-046-SB-0203	1	1	1	1
	ADA-046-SB-0305	1	1	1	1
ADA-047	ADA-047-SS	1	1	1	1
	ADA-047-SB-0203	1	1	1	1
	ADA-047-SB-0305	1	1	1	1
ADA-048	ADA-048-SS	1	1	1	1
	ADA-048-SB-0203	1	1	1	1
	ADA-048-SB-0305	1	1	1	1
ADA-049	ADA-049-SS	1	1	1	1
	ADA-049-SB-0203	1	1	1	1
	ADA-049-SB-0305	1	1	1	1
ADA-050	ADA-050-SS	1	1	1	1
	ADA-050-SB-0203	1	1	1	1
	ADA-050-SB-0305	1	1	1	1
ADA-051	ADA-051-SS	1	1	1	1
	ADA-051-SB-0203	1	1	1	1
	ADA-051-SB-0305	1	1	1	1
ADA-052	ADA-052-SS	1	1	1	1
	ADA-052-SB-0203	1	1	1	1
	ADA-052-SB-0305	1	1	1	1
ADA-053	ADA-053-SS	1	1	1	1
	ADA-053-SB-0203	1	1	1	1
	ADA-053-SB-0305	1	1	1	1

TABLE 8-9

LISTING OF SURFACE AND SUBSURFACE SOIL SAMPLES AND LABORATORY ANALYSES⁽⁴⁾
ACTIVE DETONATION AREA (ADA)
SIERRA ARMY DEPOT
HERLONG, CALIFORNIA
PAGE 4 OF 4

Sample Location	Sample Number	Energetics		Metals	Asbestos
		Nitroaromatics / Nitramines SW 846 Method 8330	Perchlorate SW 846 6850 ⁽²⁾	Title 22 SW-846 Method 6010B	U.S. EPA Region 1 Soil Screening Protocol
NA	Field Duplicates ⁽³⁾	7	7	7	7
NA	Trip Blanks ⁽⁴⁾	NA	NA	NA	NA
NA	Rinsate Blanks ⁽⁵⁾	NA	NA	NA	NA
NA	Ambient Condition Blanks ⁽⁶⁾	1	1	1	1
NA	Matrix Spikes ⁽⁷⁾	7	7	7	7
NA	Matrix Spike Duplicates ⁽⁸⁾	7	7	NA	NA
Surface and Subsurface Soil and Quality Control Samples		148	148	141	141

1 See Section 11 of this Closure Plan for specific analysis requirements and analyte lists.

2 Identified by DoD Perchlorate Policy

3 Field duplicates will be collected at a frequency of 1 per every 20 environmental samples (minimum of one field duplicate per fraction).

4 Trip blanks will not be collected because they are only collected for volatile analysis.

5 Environmental samples will be collected by directly filling the sample bottle and/or use of a disposable plastic trowel; therefore, no rinsate blanks are required for this matrix.

6 Ambient condition blanks are optional samples that may be collected based on the judgment of the Field Operations Leader.

7 Matrix spikes are collected for all organic and inorganic parameters at a frequency of 1 per every 20 field samples per matrix.

8 Matrix spike duplicates are collected for all organic parameters. Laboratory duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of 1 per every 20 field samples per matrix per fraction.

Note* SS denotes a surface soil sample to be collected at a depth up to 6 inches below ground surface, and SB denotes a subsurface sample to be collected at the depth (in feet) as indicated by the last four digits of the sample number.

NA — Not applicable.

U.S. EPA — United States Environmental Protection Agency.

TABLE 8-10

LISTING OF SURFACE SOIL SAMPLES AND LABORATORY ANALYSES⁽¹⁾
UXO AREA
SIERRA ARMY DEPOT
HERLONG, CALIFORNIA

Sample Location	Sample Number	Energetics	
		Nitroaromatics / Nitramines SW 846 Method 8330	Perchlorate SW 846 6850 ⁽²⁾
UXO-001	UXO-001-SS	1	1
UXO-002	UXO-002-SS	1	1
UXO-003	UXO-003-SS	1	1
UXO-004	UXO-004-SS	1	1
UXO-005	UXO-005-SS	1	1
UXO-006	UXO-006-SS	1	1
UXO-007	UXO-007-SS	1	1
UXO-008	UXO-008-SS	1	1
UXO-009	UXO-009-SS	1	1
UXO-010	UXO-010-SS	1	1
NA	Field Duplicates ⁽³⁾	1	1
NA	Trip Blanks ⁽⁴⁾	NA	NA
NA	Rinsate Blanks ⁽⁵⁾	NA	NA
NA	Ambient Condition Blanks ⁽⁶⁾	1	1
NA	Matrix Spikes ⁽⁷⁾	1	1
NA	Matrix Spike Duplicates ⁽⁸⁾	1	1
Surface Soil and Quality Control Samples		14	14

1 See Section 11 of this Closure Plan for specific analysis requirements and analyte lists.

2 Identified by DoD Perchlorate Policy

3 Field duplicates will be collected at a frequency of 1 per every 20 environmental samples (minimum of 1 field duplicate per fraction).

4 Trip blanks will not be collected because they are only collected for volatile analysis.

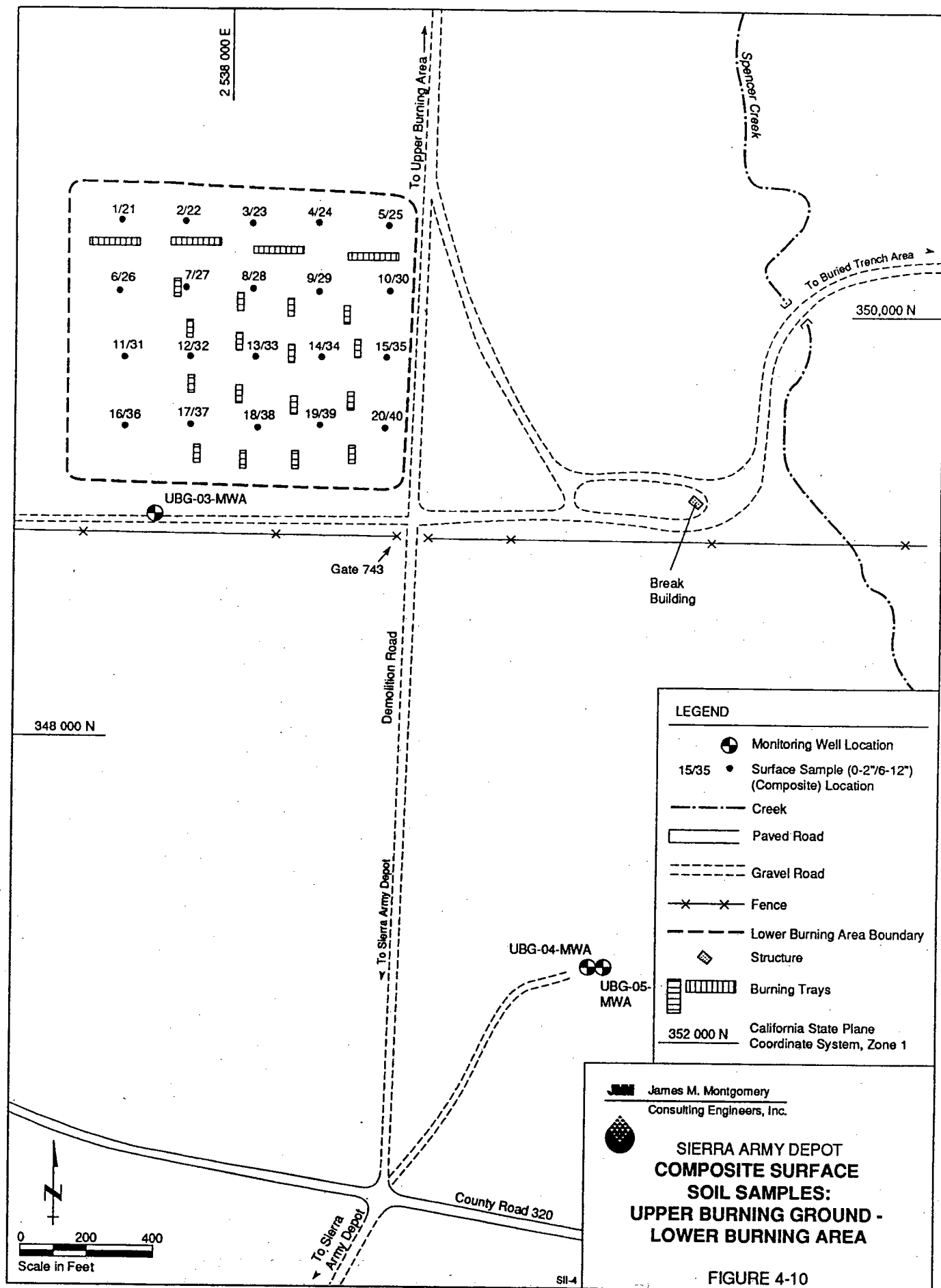
5 Environmental samples will be collected by directly filling the sample bottle and/or use of a disposable plastic trowel; therefore, no rinsate blanks are required for this matrix.

6 Ambient condition blanks are optional samples that may be collected based on the judgment of the Field Operations Leader.

7 Matrix spikes are collected for all organic and inorganic parameters at a frequency of 1 per every 20 field samples per matrix.

8 Matrix spike duplicates are collected for all organic parameters. Laboratory duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of 1 per every 20 field samples per matrix per fraction.

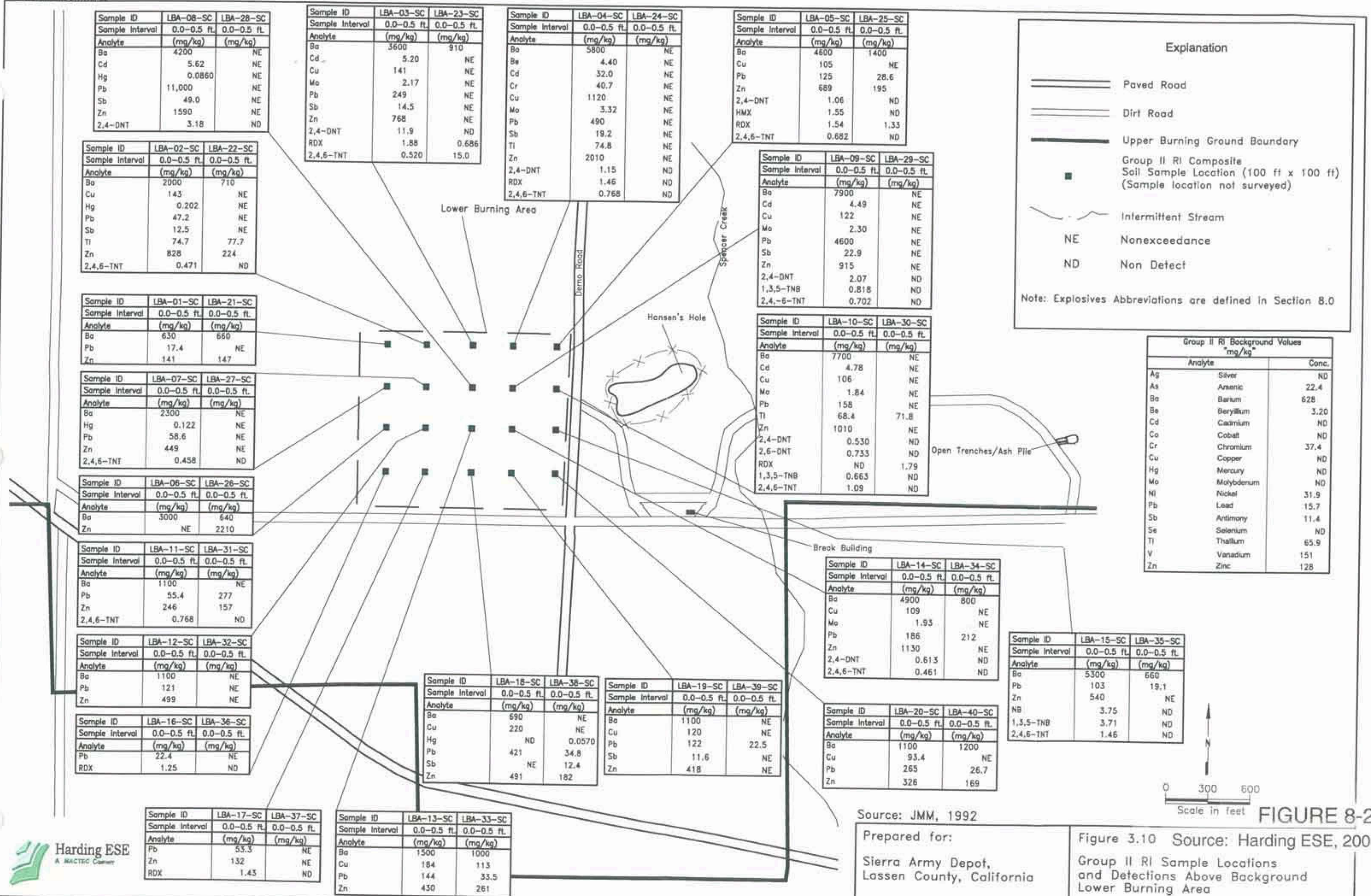
NA — Not applicable.

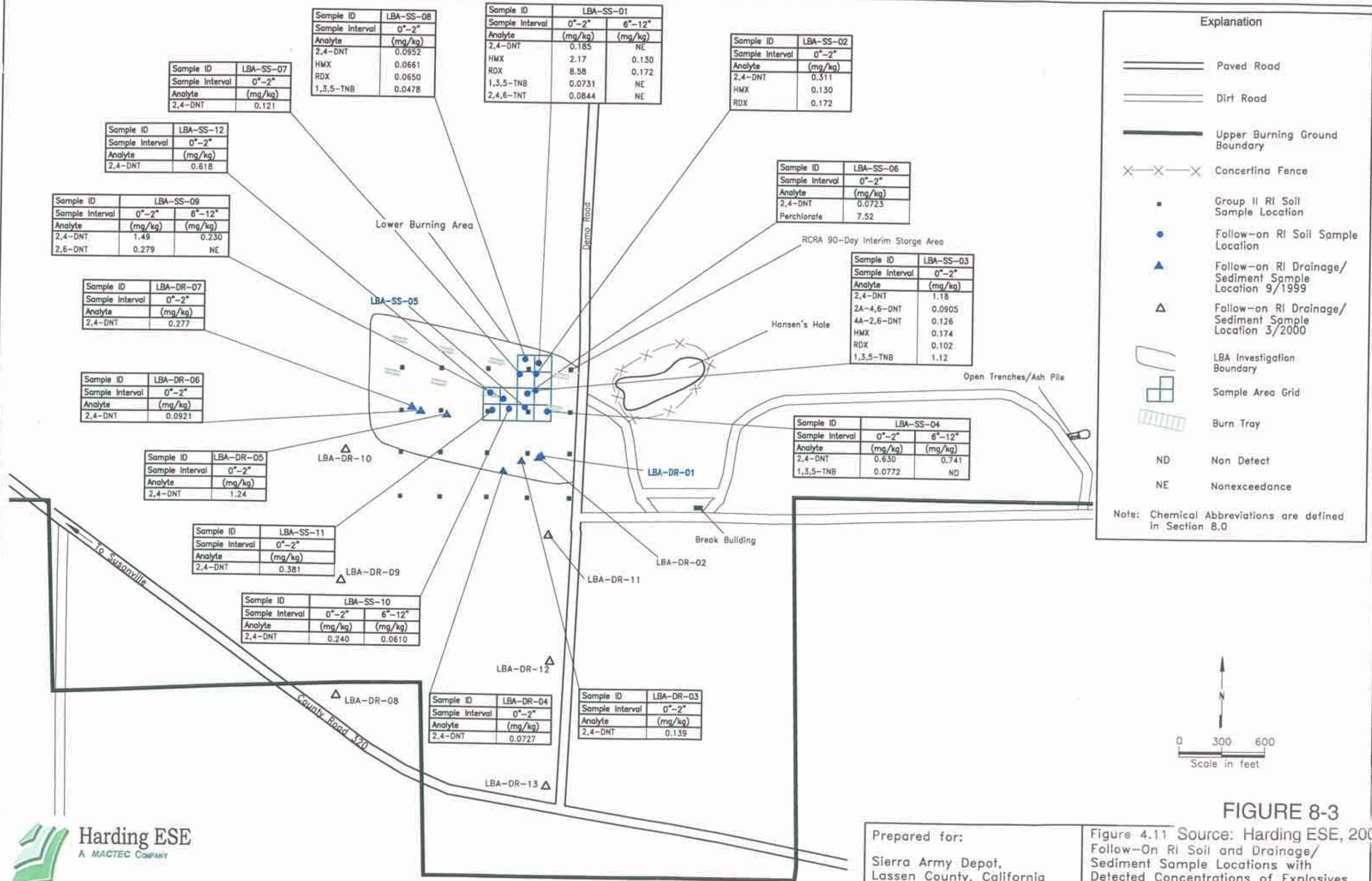


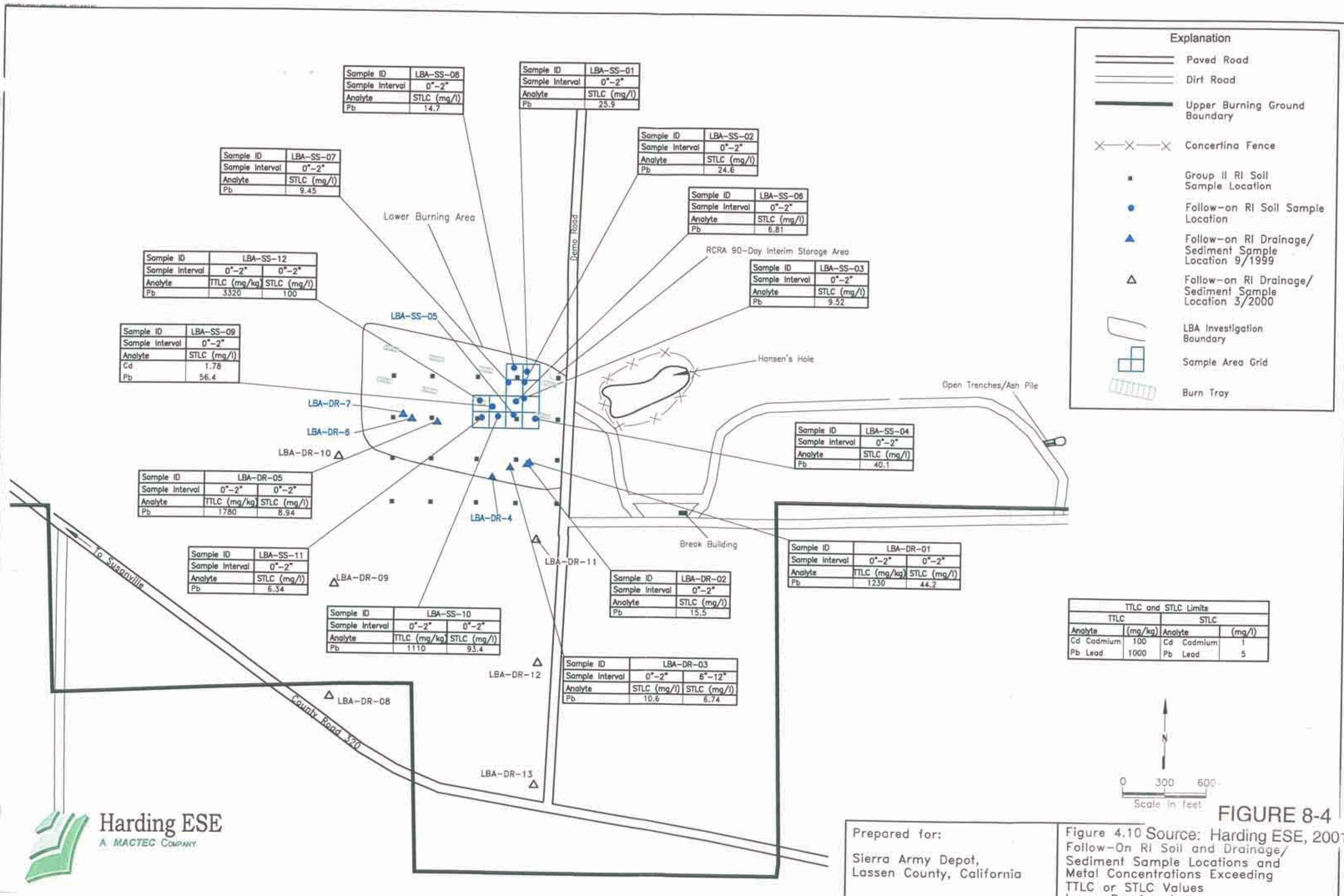
Source: JMM, 1992

4-20

FIGURE 8-1



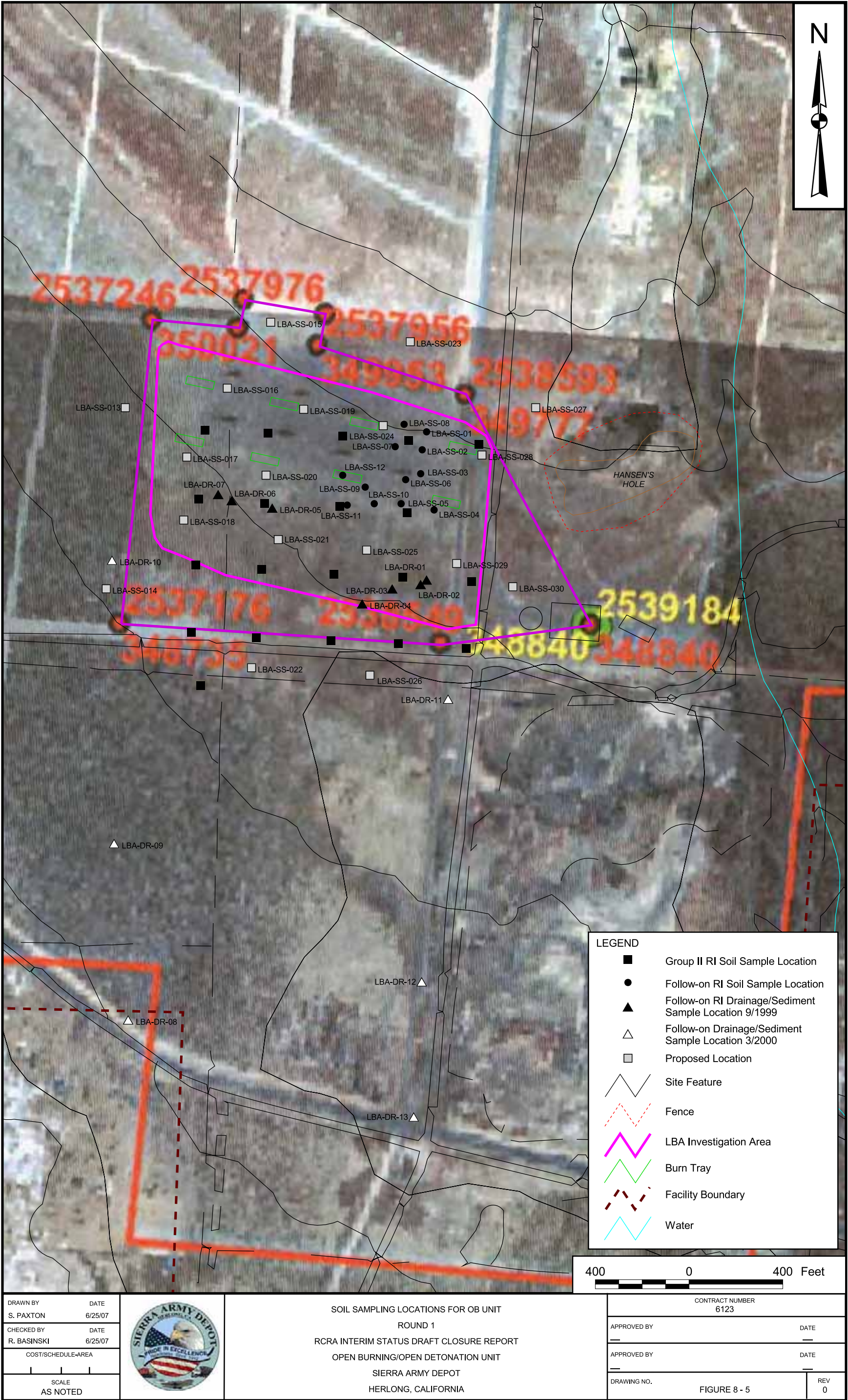




Harding ESE
A MACTEC COMPANY

Prepared for:
Sierra Army Depot,
Lassen County, California

Figure 4.10 Source: Harding ESE, 2001
Follow-On RI Soil and Drainage/
Sediment Sample Locations and
Metal Concentrations Exceeding
TtLC or STLC Values



DRAWN BY	DATE
S. PAXTON	6/25/07
CHECKED BY	DATE
R. BASINSKI	6/25/07
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	



SOIL SAMPLING LOCATIONS FOR OB UNIT
ROUND 1
RCRA INTERIM STATUS DRAFT CLOSURE REPORT
OPEN BURNING/OPEN DETONATION UNIT
SIERRA ARMY DEPOT
HERLONG, CALIFORNIA

CONTRACT NUMBER 6123	
APPROVED BY	DATE
APPROVED BY	DATE
DRAWING NO.	REV
FIGURE 8 - 5	0



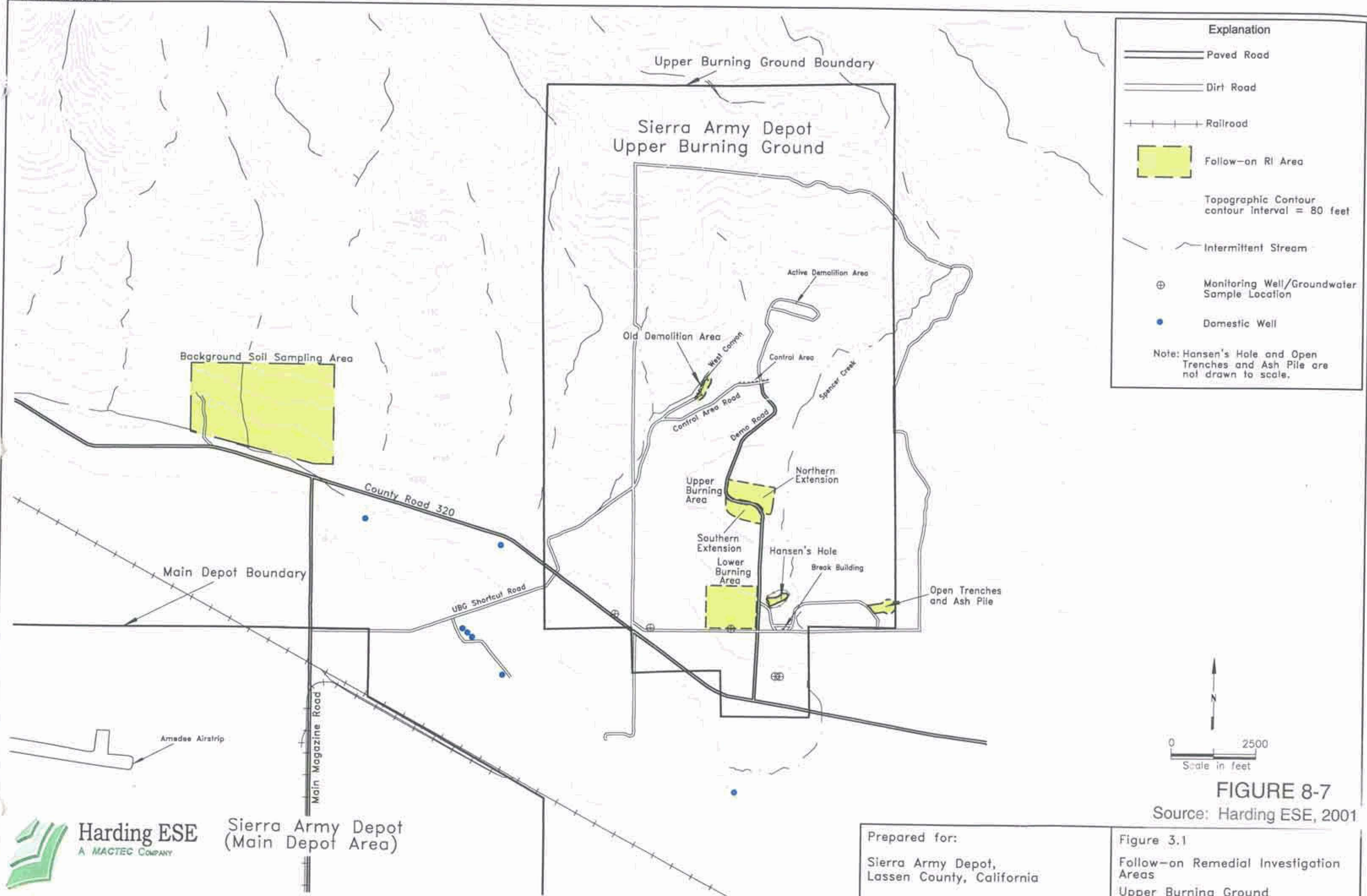


FIGURE 8-7
Source: Harding ESE, 2001

9.0 GROUNDWATER INVESTIGATIONS – 22 CCR 66265.112(B)(4)

This section provides a general overview of the geology and hydrogeology of the site, a summary of previous groundwater investigations, and a description of the additional groundwater investigations that are proposed for Closure purposes.

9.1 GENERAL GEOLOGY AND HYDROGEOLOGY

The Honey Lake Valley is located in the Basin and Range Province, and is characterized by elongate northwest-trending valleys bordered by block-faulted mountain ranges. The geologic history of the Honey Lake Valley is characterized by Tertiary block faulting, crustal extension and graben formation, volcanism, erosion and valley fill, and finally lacustrine deposition. Honey Lake Valley is an area of crust that was dropped downward relative to the surrounding blocks. The western and southern sides of the valley are surrounded by the Diamond and Fort Sage Mountains (Figure 9-1). The Virginia Mountains border the eastern and southeastern sides of the Valley. The Shaffer, Skedaddle, and the Amedee Mountains border the northern side of the Valley. Figure 9-1 is a geologic map that shows the distribution of rock types and sedimentary deposits in the Honey Lake area. The Diamond and Fort Sage Mountains on the south and southwestern sides of the Valley are composed of the oldest rocks in the area (granites and other igneous rock types of Cretaceous age). The Diamond Mountains represent a block of basement rocks that were thrust upward relative to the Valley. The Walker Lake fault is a large vertical fault that separates the Diamond Mountains from the Valley (see Figure 9-1) and along which significant vertical movement took place. The volcanic rocks that compose most of the other mountain ranges were deposited as block faulting occurred. As block movement proceeded, erosion rates increased and the valley was partially filled with alluvial fan deposits and alluvium (gravel, sands, and silt). Finally, the Valley filled with water during the Pleistocene Epoch when precipitation was more abundant. Thick layers of silt and clay were deposited in the Valley. Honey Lake is all that remains of the large lake that once filled the entire Valley.

The Main Depot lies on the relatively flat surface of lacustrine deposits near the center of the Valley (Figure 9-1). The surface elevation of the Main Depot varies from approximately 4,000 to 4,130 feet above mean sea level (msl). The UBG lies on the southern flank of the Amedee Mountains, where the terrain is rugged and elevations range from 4,040 to 5,480 feet above msl. The LBA is located on the south side of the UBG at an elevation of about 4,120 feet above msl. The ADA is located farther north up the flank of the mountains, at an elevation of about 4,560 feet above msl. Thus, the ADA is about 440 feet higher in elevation than the LBA.

The Amedee Mountains and the adjacent Skedaddle Mountains are composed of fractured volcanic rocks, including basalt, andesite, and rhyolite flows and flow breccias. A fault plane bounds the southern edge of these mountains and separates the volcanic rocks on the north from the valley fill and lacustrine sedimentary deposits that lie to the south and southwest. Geologic logs of boreholes and monitoring wells drilled within and south of the UBG were used to construct geologic cross section A-A' (Figure 9-2), that was originally presented in the Group II RI (JMM, 1992). Cross section A-A' runs from the north, starting at boring UBG-02-SB which is located in the central portion of the UBG, to the south side of the UBG to UBG-04-MWA (Figure 9-3). Basalt and other volcanic rocks are present at the ground surface throughout most of the northern two-thirds of the UBG. The basalt is veneered with a very thin (less than 2 feet thick) layer of soil. The valley fill and lacustrine deposits are only present in the southern one-third of the UBG. In borehole UBG-02-SB, the sedimentary deposits are 88.5 feet thick and basalt was encountered at about 4,150 feet above msl. On the south side of the UBG in boring UBG-01-SB, the sediments were 205 feet thick and volcanic bedrock was encountered at a much lower elevation (approximately 3,870 feet above msl). Farther south, driller's logs from domestic water wells indicate that the sedimentary deposits are 400 to 500 feet thick, or thicker (Harding ESE, 2001). Thus, the thickness of sediments increases rapidly toward the south and southwest (toward the center of the Valley).

Two monitoring wells (UBG-08-MWA and UBG-09-MWA) have been recently installed near Hansen's Hole. On the southwest side of Hansen's Hole, the thickness of unconsolidated sediments was 70 feet, which is similar to the thickness of sediments observed in UBG-02-SB (88.5 feet) and UBG-03-MWA (approximately 100 feet). However, on the northeast side of Hansen's Hole, the thickness of sediments encountered in UBG-08-MWA was less than 5 feet. Hence, there is a substantial amount of variation on the surface of volcanic bedrock, and the depth to volcanics in the southern third of the UBG is highly variably.

As stated above, the valley-fill and lacustrine deposits shown in cross-section A-A' (Figure 9-2) are not present at the ADA. Basalt, which is highly fractured, and other volcanic rocks are present at the ground surface or covered by a thin layer of soil.

Somewhere between the ADA and the LBA, sedimentary units are deposited on top of the basalt. The sedimentary deposits are up to 88 feet thick in the vicinity of the LBA. These deposits consist of four different lithologic units. The uppermost layer consists of alluvial fan deposits, including gravel, sand, and silt. This unit can be as thick as 45 feet (Figure 9-2). Beneath the alluvium lie finer-grained sand, silt, and clay, which were deposited along the lakeshore when the large lake was still present in the Valley. This lithologic unit can be as thick as 50 feet; however, it thins rapidly to the south and to the north. The next lower unit is composed of lacustrine silts and clays that are olive colored. The lowermost unit is nearly

the same texture as the unit above (i.e., silt and clay), but it is dark gray in color. As shown on Figure 9-2, monitoring wells UBG-03-MWA and UBG-04-MWA are screened in the dark gray silt and clay unit.

Groundwater recharge is relatively low over the entire Honey Lake Basin. The highest rates of recharge occur in the mountains at the higher elevations, where snowfall and rainfall are greatest and evaporation is lowest. The mountain recharge results in the highest groundwater elevations to be located in the mountains. Evaporation and groundwater production for agriculture and drinking supplies removes groundwater in the Valley bottom. As a result, groundwater, in general, flows from the volcanic rocks in the mountains southwest and west toward Honey Lake. The groundwater in the volcanics must first pass through the thick sequence of lacustrine silt and clay deposits (lake deposits) before it can discharge to Honey Lake. Flowing wells exist to the west of the Upper Burning Ground.

A total of nine monitoring wells (UBG -01-MWA through UBG-09-MWA) have been installed in the silt and clay deposits along the south side of the UBG (Figure 9-3). In addition, there are seven or more domestic wells located to the south and southwest of the UBG. Groundwater levels that were measured basewide in May 1991 (Figure 9-4) show groundwater is flowing primarily toward the south and southwest from the Amedee Mountains, beneath the UBG, and toward Honey Lake. Groundwater elevations measured in wells near the UBG ranged from 4,005 feet above msl (well UBG-01-MWA) to 4,035 feet above msl (well UBG-05-MWA). The hydraulic gradient was toward the southwest at about 0.003 to 0.008 feet per foot (ft/ft). Groundwater elevations were measured more recently (June 1999) in wells in the southern portion of the UBG (Figure 9-5). Elevations ranged from 4004.6 feet above msl (well UBG-01-MWA) to 4,042.1 feet above msl (well UBG-04-MWA). The absolute elevations and the hydraulic gradients of the 1991 and the 1999 data are very similar.

Any water infiltrating into the ground surface at the LBA will have to percolate downward about 75 feet before it reaches the water table (Figure 9-2). Once it reaches the water table, lateral migration through the silt and clay deposits should be relatively slow because the hydraulic conductivity of these units should be very low. At the ADA, the ground surface elevation is about 4,560 feet above msl. Extrapolating the water table northward from monitoring well UBG-03-MWA yielded an estimated water table elevation beneath the ADA of about 4,130 feet above msl. Thus, the projected depth to groundwater beneath the ADA is about 430 feet. Any water and contaminants percolating through the surface soil at the ADA would have to migrate 430 feet downward before reaching the water table.

9.2 PREVIOUS INVESTIGATIONS

Five monitoring wells were installed along the south side of the UBG during the Group II RI (JMM, 1992). In addition, one single well (DSB-04-MWA) was chosen to represent background groundwater quality for

the entire SIAD facility. This well is located near the center of the Main Depot about 5 miles southwest of the UBG (Figure 9-4). Except for UBG-04-MWA, all of these wells are screened in the lacustrine silt and clay deposits near the water table surface. Monitoring wells UBG-01-MWA, UBG-02-MWA, and UBG-03-MWA were each sampled twice in 1991 during the Group II RI, and wells UBG-04-MWA and UBG-05-MWA were each sampled once (Table 9-1). The background well was sampled twice in 1990 (Table 9-2). These samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), explosives, metals, and anions. No explosive compounds were detected in the five UBG monitoring wells. The sodium and sulfate concentrations in UBG-01-MWA were significantly higher than concentrations in the other four monitoring wells. The sodium concentrations in UBG-01-MWA was, however, very similar to the concentrations detected in the background well. According to the Group II RI (JMM, 1992), the concentrations of arsenic, copper, and lead in UBG-01-MWA and the lead in UBG-02-MWA exceeded background levels. However, the RI suggests that these isolated exceedances are very close to background levels, probably do represent background, and are not due to site-related contamination (JMM, 1992).

During the subsequent sampling rounds in 1992 through 2000, groundwater samples were only analyzed for explosives and metals. However, samples collected in 1999 and 2000 were analyzed for perchlorate in addition to explosives and metals. Analytical results (positive detects only) of groundwater samples collected from the five monitoring wells in 1998 through 2000 are listed in Table 9-3. Analytical results for four additional background samples collected in 1992 through 1994 are listed in Table 9-4. The 1999 through 2000 UBG sample results (Table 9-3) show that a maximum arsenic concentration of 380 µg/L was detected twice in monitoring well UBG-01-MWA. However, arsenic concentrations in the background well ranged from 240 to 287 µg/L (Table 9-4). Harding ESE suggested that the arsenic levels in UBG-01-MWA was due to the naturally elevated levels of arsenic commonly found in the Valley. The high levels of sodium found in UBG-01-MWA was also attributed to the naturally elevated levels of sodium commonly found in the Valley and found in the background well.

Overall, no organic compounds were detected in the five UBG monitoring wells and metal concentrations were no higher than, and in many cases were lower than, the concentrations detected in the background well.

Additional groundwater sampling was planned for the UBG monitoring wells and the water supply wells located near the south side of the UBG (Harding ESE, 2002a, 2002b); however, it is not known whether this planned sampling event was performed.

9.3 OPEN BURNING UNIT

OB operations consisted of the burning of solid propellants or other solid energetic materials within containment pans. The OB Unit at SIAD consisted of up to 40 burn pans during the operating life of the unit. Each burn pan had a capacity of up to 1,000 pounds NEW of propellant. The OB pans were located in a pad area that comprises approximately 18 acres.

Section 1.6.1 contains a general description of the types of waste munitions and explosives that were treated at the SIAD OB Unit. Based on the information presented in Section 1.6.1, explosives, propellants, perchlorates, and metals are the primary contaminants of potential concern for the open burning area.

9.3.1 Conceptual Site Model

Contaminants could have been released to the surrounding soils from the pans during OB operations. The OB treatment resulted in a plume that often reach several hundred feet in height. Particulate material resulting from the burning was entrained within the plumes. This particulate matter consisted of inorganic materials such as metal compounds contained in explosive formulations and donor materials. In addition, untreated material could have been ejected during the OB operations and ash could have been released after burning operations were complete. Any releases would have initially been deposited onto the surface soils. The particles with the greatest density and largest mass would tend to fall out in close proximity to the burn pans. As the distance from the pans increased, the expected concentrations of contaminants in the surface soils would decrease. The highest concentrations of contaminants in surface soils (0 to 1 foot bgs) would be expected to be found in close proximity (zero to fifty feet) to the OB pans. Historically, before burn pans were used, OB took place directly on the ground surface or in trenches. In which case, any unburned materials would have remained on the surface soil.

Contaminants in surface soils could infiltrate into the subsurface soils during precipitation events. In general, the highest contaminant concentrations of explosives and metals would be expected to be found in the surface soils with concentrations decreasing with increases in depth. In the case of perchlorates, which are highly soluble in water, old releases of perchlorate would tend to move at the same rate as water moves through surface soils into the subsurface. However, in the case of the SIAD OB Unit, the rate of water movement would be relatively slow because of the low precipitation rate (approximately 6 inches per year) and high evaporation rate (approximately 40 inches per year).

In order for the groundwater underlying the OB Unit to have been contaminated, a complete transport pathway must exist. Contaminants deposited onto surface soils would have to leach through the surface soils into the subsurface soils, and then migrate down to the water table (i.e., saturated zone), which is

approximately 75 to 90 feet bgs. If contaminants are not found in subsurface soils, then groundwater underlying the OB Unit should not be contaminated as a result of OB Unit activities.

9.3.2 Groundwater Monitoring

There are nine monitoring wells that currently exist along the south side of the UBG (Figure 9-3). One of these wells, UBG-03-MWA, lies immediately south of the LBA (Figures 9-3 and 9-5). To date, explosive compounds have not been detected in any of these monitoring wells. Metal concentrations detected in UBG-03-MWA have not exceeded background levels. In addition, the water table is about 75 to 90 feet bgs so contaminants, if present in the soil, could take decades before reaching the water table. Therefore, no additional monitoring wells for the OB Unit closure will need to be installed, nor will it necessary to perform additional sampling and analysis of existing wells.

9.3.3 Analytical Program

No analytical program is recommended for groundwater.

9.4 OPEN DETONATION UNIT

The OD Unit (i.e., ADA) consists of 14 pits dug into the foothills of the Amedee Mountains (see Figure 1-3). The area encompassing the pits totals approximately 30 acres. The pits are dug with sides ranging from a few feet to more than 30 feet at the pit back wall. The pits are sloped inward from the entrance toward the back of the pits to control run-on/runoff. No liners or structures were used in the pits. Figure 1-3 shows the layout and relative dimensions of the OD pits.

9.4.1 Conceptual Site Model

Contaminants could have been released to the soils from the OD pits as the result of open detonations of military munitions/explosives and the OB of rocket motors.

Open Detonation: OD treatments only took place within the fourteen pits. The blasts resulted in a plume which contained large quantities of particulate matter. The particulate matter consisted of dirt from the floors and walls of the pits, fragmented metal casings from the munitions items, and inorganic materials that were part of the explosive formulation such as lead azide. The particles with the greatest density and largest mass would tend to fall out in close proximity to the detonation points. As the distance from the detonation points increased, the expected concentrations of contaminants in the surface soils would decrease. Most of the particulates from the plume were initially deposited onto the surface soils within the pits and in close proximity to the pits. Therefore, the greatest concentrations of contaminants in surface soils (0 to 1 foot bgs) would be expected to be found within the pits and in close proximity to the

pits. As the distance from the pits increases, the expected concentrations of contaminants in the surface soils would decrease. Mixtures of surface soil and subsurface soils took place as the result of the entrainment of the pit soils within the blast and subsequent redeposition. As a result, subsurface soils within the OD pits are likely to contain significant concentrations of contaminants. Outside the pits, contamination of subsurface soils would only have taken place as the result of precipitation-induced infiltration of contaminants from surface soils. In general, the highest contaminant concentrations of explosives and metals would be expected to be found in the surface soils with concentrations decreasing with increases in depth and distance from the OD pits.

Rocket Motors: OB of large rocket motors took place within the OD pits. The rocket motors were laid on their sides and explosives charges used to crack the casing open and initiate burning of the propellant contained within the casing. The burning operation resulted in emission plumes. Little, if any, soils were entrained within the plumes because no detonations were involved and the propellants were contained within the rocket motor casing. Particulate matter in the plume consisted primarily of inorganic materials such as aluminum compounds (Al_2O_3) and chloride compounds. The greatest concentrations of contaminants in surface soils (0 to 1 foot bgs) would be expected to be found within the pits and in close proximity to the pits. Outside the pits, contamination of subsurface soils would only have taken place as the result of precipitation-induced infiltration of contaminants from surface soils. As the distance from the pits increases, the expected concentrations of contaminants in the surface soils would decrease.

In order for the groundwater underlying the OD Unit to have been contaminated, a complete transport pathway must exist. Contaminants deposited onto surface soils would have to leach through the surface soils into the subsurface soils, and then migrate roughly 400 to 450 feet downward to the water table surface. If contaminants are not found in subsurface soils, then groundwater underlying the OD Unit will not be contaminated.

9.4.2 Groundwater Monitoring

There are nine monitoring wells that currently exist along the south side of the UBG (Figures 9-3 and 9-5). Explosive compounds have not been detected in any of these wells to date. Metal concentrations detected have not been significantly above background. In addition, the water table is about 400 to 450 feet bgs at the OD Unit, so contaminants, if present in the soil, could take decades before they would reach the water table. The probability of contaminants from the OD Unit ever reaching the groundwater system is extremely low. Therefore, no additional monitoring wells or groundwater monitoring is recommended at this time. Once the results are obtained from the OD soil sampling program (see Section 8.0) and the levels of contaminants, if any, in the surface soils are known, then the need to investigate the presence of contaminants at depth or to install additional monitoring wells for the OB Unit closure can be reassessed.

9.4.3 Analytical Program

No analytical program is recommended for groundwater.

9.5 FIELD SAMPLING PLAN

A field sampling plan (FSP) developed for the field program will not include a component for groundwater investigations. However, the FSP will be amended at a later date to include additional subsurface investigations if significant contamination is detected in near-surface soils during the soil investigations at either the OB or the OD Units.

POSITIVE GROUNDWATER RESULTS - ROUND 1 - UPPER BURNING GROUND

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
UBG-01-MWA	40.0	28-apr-1991	00	Total dissolved solids	4810000.000	ug/l
		28-apr-1991	00	Total dissolved solids	4900000.000	ug/l
		28-apr-1991	SD20	Lead	3.900	ug/l
		28-apr-1991	SD22	Arsenic	390.000	ug/l
		28-apr-1991	SD22	Arsenic	620.000	ug/l
		28-apr-1991	SD23	Silver	0.274	ug/l
		28-apr-1991	SS10	Barium	12.400	ug/l
		28-apr-1991	SS10	Barium	17.500	ug/l
		28-apr-1991	SS10	Calcium	18500.000	ug/l
		28-apr-1991	SS10	Calcium	19100.000	ug/l
		28-apr-1991	SS10	Copper	37.300	ug/l
		28-apr-1991	SS10	Sodium	1500000.000	ug/l
		28-apr-1991	SS10	Sodium	1600000.000	ug/l
		28-apr-1991	TT10	Chloride	1300000.000	ug/l
		28-apr-1991	TT10	Chloride	1300000.000	ug/l
		28-apr-1991	TT10	Sulfate	2000000.000	ug/l
		28-apr-1991	TT10	Sulfate	2000000.000	ug/l
UBG-02-MWA		28-apr-1991	00	Total dissolved solids	550000.000	ug/l
		28-apr-1991	SD20	Lead	1.630	ug/l
		28-apr-1991	SD22	Arsenic	69.600	ug/l
		28-apr-1991	SS10	Barium	12.800	ug/l
		28-apr-1991	SS10	Calcium	7780.000	ug/l
		28-apr-1991	SS10	Copper	21.800	ug/l
		28-apr-1991	SS10	Sodium	130000.000	ug/l
		28-apr-1991	TT10	Chloride	100000.000	ug/l
UBG-03-MWA	90.0	28-apr-1991	00	Total dissolved solids	350000.000	ug/l
		28-apr-1991	SS10	Barium	63.200	ug/l
		28-apr-1991	SS10	Calcium	23000.000	ug/l
		28-apr-1991	SS10	Sodium	57000.000	ug/l
		28-apr-1991	TT10	Chloride	20100.000	ug/l
		28-apr-1991	TT10	Sulfate	77700.000	ug/l
		28-apr-1991	UM18	2-(2-M-Butoxyethoxy) ethanol (TIC)	10.000	ug/l
		28-apr-1991	UM18	Unknown 535 (TIC)	7.000	ug/l
UBG-04-MWA	88.0	19-may-1991	00	Total dissolved solids	355000.000	ug/l
		19-may-1991	SD22	Arsenic	11.600	ug/l
		19-may-1991	SS10	Barium	38.000	ug/l
		19-may-1991	SS10	Calcium	17900.000	ug/l
		19-may-1991	SS10	Sodium	82000.000	ug/l
		19-may-1991	TT10	Chloride	22100.000	ug/l
		19-may-1991	TT10	Sulfate	31900.000	ug/l

Notes: (TIC) indicates a tentatively identified compound.

'>' indicates actual concentration is greater than the upper certified limit.

Source: (JMM, 1992)

TABLE 9-1

Table 6-28

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Pg. 1

POSITIVE GROUNDWATER RESULTS - ROUND 2 - UPPER BURNING GROUND

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
UBG-01-MWA	30.0	19-jul-1991	00	Total dissolved solids	4620000.000	ug/l
		19-jul-1991	SD22	Arsenic	220.000	ug/l
		19-jul-1991	SD23	Silver	0.330	ug/l
		19-jul-1991	SS10	Barium	10.100	ug/l
		19-jul-1991	SS10	Calcium	17600.000	ug/l
		19-jul-1991	SS10	Sodium	1500000.000	ug/l
		19-jul-1991	TT10	Chloride	1100000.000	ug/l
		19-jul-1991	TT10	Sulfate	1800000.000	ug/l
UBG-02-MWA	40.0	19-jul-1991	00	Total dissolved solids	529000.000	ug/l
		19-jul-1991	00	Total dissolved solids	536000.000	ug/l
		19-jul-1991	SD22	Arsenic	51.600	ug/l
		19-jul-1991	SD22	Arsenic	67.300	ug/l
		19-jul-1991	SS10	Barium	12.300	ug/l
		19-jul-1991	SS10	Barium	14.000	ug/l
		19-jul-1991	SS10	Calcium	8050.000	ug/l
		19-jul-1991	SS10	Calcium	8060.000	ug/l
		19-jul-1991	SS10	Copper	12.900	ug/l
		19-jul-1991	SS10	Copper	12.900	ug/l
		19-jul-1991	SS10	Sodium	130000.000	ug/l
		19-jul-1991	SS10	Sodium	132000.000	ug/l
		19-jul-1991	TT10	Chloride	110000.000	ug/l
		19-jul-1991	TT10	Chloride	110000.000	ug/l
		19-jul-1991	TT10	Sulfate	98500.000	ug/l
		19-jul-1991	TT10	Sulfate	102000.000	ug/l
UBG-03-MWA	95.0	19-jul-1991	00	Total dissolved solids	337000.000	ug/l
		19-jul-1991	SS10	Barium	70.700	ug/l
		19-jul-1991	SS10	Calcium	22200.000	ug/l
		19-jul-1991	SS10	Sodium	47900.000	ug/l
		19-jul-1991	TT10	Chloride	15300.000	ug/l
		19-jul-1991	TT10	Sulfate	75200.000	ug/l
		19-jul-1991	UM18	Unknown 533 (TIC)	6.000	ug/l
		19-jul-1991	UM18	Unknown 649 (TIC)	10.000	ug/l
UBG-05-MWA	45.0	10-aug-1991	00	Total dissolved solids	468000.000	ug/l
		10-aug-1991	SD22	Arsenic	6.720	ug/l
		10-aug-1991	SS10	Barium	8.930	ug/l
		10-aug-1991	SS10	Calcium	16600.000	ug/l
		10-aug-1991	SS10	Sodium	111000.000	ug/l
		10-aug-1991	TT10	Chloride	60000.000	ug/l
		10-aug-1991	TT10	Sulfate	80900.000	ug/l
		10-aug-1991	UM18	Unknown 574 (TIC)	4.000	ug/l

Notes: (TIC) indicates a tentatively identified compound.

'>' indicates actual concentration is greater than the upper certified limit.

Source: (JMM, 1992)